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RAPPORT

EN SYSTEMATISK OVERSIKT

Demirjians utviklingsstadier på visdomstenner for estimering av kronologisk alder

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Tittel Demirjians utviklingsstadier på visdomstenner for estimering av kronologisk alder: en systematisk oversikt.

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Hovedbudskap

Demirjians utviklingsstadier av tenner benyttes til å anslå alder på barn og unge. Denne systematiske oversikten sammenfatter den forskningsbaserte dokumentasjonen om hvordan alder fordeler seg i Demirjians utviklingsstadier fra A til H for visdomstenner.

Vi fant 18 relevante tverrsnittsstudier, alle publisert etter 2005. De var fra 13 ulike land, fra alle verdensdeler unntatt Australia. Studiene presenterte gjennomsnittlig alder for deltakerne i hvert enkelt av utviklingsstadiene.

Et hovedfunn er at flertallet av studiene ble gjennomført på en slik måte at vi ikke kan stole på resultatene. Antall deltakere i hvert alderskull og det totale aldersspennet i studien påvirker resultatene. Hvis studiene ikke tar hensyn til dette, blir det en systematisk feil som kalles aldersmimikering.

Vi vurderte at kun noen få av studiene var utført på en slik måte at de gir en god nok beskrivelse av metodens evne til å anslå alder.

Studiene gir ikke grunnlag for å konkludere om det finnes forskjeller i utvikling av visdomstenner mellom populasjoner fra ulike regioner.

Tittel:
Demirjians utviklingsstadier på visdomstenner for estimering av kronologisk alder: en systematisk oversikt

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Publikasjonstype:
Systematisk oversikt
En systematisk oversikt er resultatet av å
- innhente
- kritisk vurdere og
- sammenfatte

relevante forskningsresultater ved hjelp av forhåndsdefinerte og eksplisitte metoder.

Svarer ikke på alt:
- Ingen studier utenfor de eksplisitte inklusjonskriteriene
- Ingen helseøkonomisk evaluering
- Ingen anbefalinger

Hvem står bak denne publikasjonen?
Folkehelseinstituttet

Når ble litteratursøket utført?
Søk etter studier ble avsluttet mai 2016.

Eksterne fagfeller:
Bjørn Anton Graff, Forskningssjef, Vestre Viken HF.
Sigrid Ingeborg Kvaal, Førsteamanuensis, Universitetet i Oslo.

Sammendrag

Innledning

Hvert år kommer det unge asylsøkere til Norge som ikke vet hvor gamle de er eller som ikke kan dokumentere egen alder. For å sikre at barn får de rettigheter de har krav på og at voksne ikke blir behandlet som barn, er det nødvendig å fastsette en kronologisk alder. I Norge har det i flere år vært benyttet evaluering av modning av skjelett i hånd og av tannutvikling for å estimere alder på asylsøkere. Disse metodene har i stor grad blitt kritisert for ikke å være presise, men per dags dato er det ikke funnet bedre metoder.

I 2016 fikk Folkehelseinstituttet et nasjonalt fagansvar for å evaluere og forbedre metodene (fra 1.1. 2017 overført med Avdeling for Rettsmedisinske fag til Oslo universitetssykehus). Den rettsmedisinske faggruppen har i samarbeid med Kunnskapssenteret for helsetjenesten i Folkehelseinstituttet gjennomført en systematisk kartlegging av det vitenskapelige grunnlaget for flere metoder som benyttes til medisinske aldersvurderinger.

Formålet med denne systematiske oversikten er å få en oversikt over den vitenskapelige dokumentasjonen om hvordan kronologisk alder fordeler seg i utviklingsstadier av visdomstenner (tredje molar), og å belyse eventuelle variasjoner mellom ulike populasjoner.

Siden Demirjans utviklingsstadier for jeksler er den metoden for aldersestimering basert på tannrøntgen med størst vitenskapelig grunnlag, valgte vi å konsentrere oss om dette systemet. Det er mest aktuelt å vurdere visdomstennene for aldersestimering av eldre tenåringer og unge voksne. I det samme tidsrommet har vi også gjennomført en systematisk oversikt over aldersestimering basert på modningsstadier for hånd fra Greulich & Pyle-atlaset.

Metode

Vi søkte etter studier i Cochrane Central Register of Controlled Trials (CENTRAL), MEDLINE, Embase og Google Scholar. Søket ble avsluttet mai 2016. Det ble utført ett felles søk for studier som benyttet røntgen av tenner eller hånd, samt CT eller MR av krageben, kne eller ankel til aldersvurdering av barn og unge mellom 10 og 25 år. To personer leste uavhengig av hverandre tittel og sammendrag for 10059 referanser. Av disse fant vi 589 publikasjoner som kunne være relevante for aldersestimering basert på tannrøntgen, og to personer vurderte disse uavhengig av hverandre i fulltekst. Vi inkluderte 18 artikler som presenterte resultater for barn og unge i hele eller deler av det angitte aldersspennet som gjennomsnittlig alder med spredningsmål for hvert av

Demirjians stadier på tredje molar. To personer vurderte uavhengig av hverandre risiko for systematiske skjevheter i de inkluderte studiene basert på QUADAS-2 sjekklisten, og så sammenfattet de dette ved diskusjon.

Resultat

Vi fant 18 tverrsnittsstudier som benyttet Demirjians stadier på jeksler for vurdering av visdomstenners utvikling, som hadde oppgitt gjennomsnittlig alder og standardavvik (spredningsmålet) og samtidig oppgitt antall deltakere. Studiene inkluderte mellom 209 til 3510 forsøkspersoner med kjent kronologisk alder. Alle studiene bestod av både gutter og jenter. Det var fire studier fra Kina, to studier hver fra Sør-Afrika og Tyrkia, og én studie hver fra henholdsvis Brasil, Canada, Frankrike, Iran, Malaysia, Malta, Spania, Storbritannia, Sør-Korea og Østerrike. Alderssammensetningen i de ulike studiene varierte i stor grad. Det smaleste aldersspennet var fra 15 år til 23 år (8 årskull) og det bredeste aldersspennet var fra 4,1år til 26,9 år (23 årskull). Vi vurderte at flertallet av studiene hadde høy risiko for en spesiell form for seleksjonsskjevhet. Forøvrig hadde studiene lav eller uklar risiko for systematiske skjevheter basert på QUADAS sjekklisten.

Gjennomsnittlig kronologisk alder for de ulike tannutviklingsstadiene varierte mye fra studie til studie. Vi fant at resultatene i høy grad var påvirket av hvilken aldersgruppe som var valgt og antall inkluderte individer i hver aldersgruppe. Denne skjevheten er tidligere beskrevet som aldersmimikering (*engelsk age mimicry*) og dette fører til at gjennomsnittsalder og standardavvik for hvert stadium blir sterkt preget av hvordan studien har valgt ut antall deltakere i hver aldersgruppe og aldersspennet på deltakerne. Kun få av de 18 artiklene hadde inkludert individer som var jevnt fordelt utover på ulike alderstrinn og omfattet et aldersspenn som var passende for å inkludere personene i alle de 8 ulike tannstadiene.

Vi kan løfte frem én studie av Lee og medarbeidere (2009) som et eksempel på hvordan deltakerne bør velges ut for å beskrive gjennomsnitt og standardavvik av alder for tannutviklingsstadier på visdomstenner på en god måte. Med denne studien viser vi hvordan man kan bruke slike data i praksis til å beskrive hvordan kronologisk alder fordeler seg på de ulike stadiene. Dette gjøres ved å beregne et såkalt prediksjonsintervall (basert på oppgitte gjennomsnitt, standardavvik og antall individer for hvert stadium), som beskriver området av kronologisk alder som en person, med et gitt observert stadium, med en gitt sannsynlighet vil havne innenfor. Vi beregnet prediksjonsintervallene basert på resultatene i studien fra Lee (2009). Beregningen viste at bredden av 95 % prediksjonsintervall for de ulike stadiene varierte fra 4,7 år til 6,8 år. For eksempel hadde individer i stadium E en gjennomsnittsalder på 16,2 år og en nedre og øvre grense for 95 % prediksjonsintervallet på 12,7 og 19,6 år.

Diskusjon

Vi fant at flertallet av de 18 inkluderte studiene, som hadde undersøkt gjennomsnittlig alder med spredning for Demirjians stadier på visdomstenner, hadde inkludert forskjellig antall individer i de ulike alderskullene. Dersom man ønsker å beskrive hvordan alder fordeler seg i tannstadier er det viktig å inkludere et likt antall personer i hver aldersgruppe. I tillegg bør aldersspennet i en slik studie være bredt nok til at man dekker alle sannsynlige aldre som vil kunne havne i de undersøkte stadiene. Det er et spesielt problem med endestadiet H som vedvarer livet ut og som også er et viktig stadium for å beskrive om en person er over eller under 18 år. Hvor man setter den øvre aldersgrensen for de inkluderte individene i en studie vil avgjøre hvilken gjennomsnittlig alder og spredning man får for dette stadiet. Jo høyere alder som er inkludert dess høyere vil aldersgjennomsnittet og tilhørende standardavvik for H stadiet bli. Det er foreslått flere fremgangsmåter for å løse dette problemet.

Variasjonen man ser mellom studier som benytter Demirjians gradering av visdomstenner har i mange tilfeller blitt tolket som forskjeller i tannutvikling mellom populasjoner og etnisiteter. Imidlertid vurderer vi at aldersmimikering er en så vesentlig kilde til variasjon at forskningsgrunnlaget er for svakt til å kunne konkludere med om slike forskjeller finnes.

Vi fant at alderssammensetningen i studier som undersøker utviklingsstadier for visdomstenner betyr mye for resultatene. Man må altså være oppmerksom på dette når man designer en studie. Aldersmimikering kan også omgås ved å anvende statistiske metoder som for eksempel «transition analysis». Det finnes ulike modeller av denne typen i litteraturen, og det trengs videre arbeid med å utarbeide metoder som benytter slike modeller for å gi best mulig beskrivelse av aldersfordelingen for de ulike stadiene. For å utføre dette arbeidet trenger man en mengde grunndata der observasjoner av kronologisk alder og stadium er oppgitt per individ. Tilgangen på slike grunndata og anvendelse av slike modeller åpner også for muligheten til å undersøke en eventuell gevinst av å kombinere vurderinger av ulike tenner for samme individ. For å ta denne metoden ut i praktisk bruk må selvsagt dataene være representative for individene som aldervurderes.

Konklusjon

Flertallet av studiene vi oppsummerte har en utførelse som gjør at man ikke kan stole på resultatene. Antall deltakere i hvert alderskull og det totale aldersspennet i studiene påvirker resultatene. Når studiene ikke tar hensyn til dette, blir det en systematisk feil som kalles aldersmimikering. Kun én av de 18 publikasjonene tok hensyn til dette problemet i sin studiedesign, og kunne derved beskrive alle de åtte Demirjian stadiene for visdomstenner på en god måte. Vi regnet ut 95 % prediksjonsintervaller til de ulike stadienes gjennomsnittsalder for denne studien, og fant at bredden på disse varierte fra 4,7 til 6,8 år. Først når vi har et større antall studier med studiedesign som unngår aldersmimikering og som har individer fra ulike regioner, kan man på best mulig måte beskrive aldersfordelingen for de ulike utviklingsstadiene, samt analysere hvorvidt regionale forskjeller spiller en rolle i sammenhengen mellom kronologisk alder og tannutvikling.

Key messages (English)

Demirjian's development stages of teeth are used to estimate the age of children and youth. This systematic review summarizes the scientific documentation about how chronological age is distributed according to Demirjian's stages from A to H for wisdom teeth.

We found 18 relevant cross-sectional studies, all published after 2005. They were from 13 different countries from all continents except Australia. The studies presented the mean age of participants in each stage.

The majority of these studies were conducted in such a way that we do not have confidence in the results. The number of participants in each age group and the total age range of the study influence the results. If studies do not consider this, a bias called age mimicry occurs.

We considered that only a few studies were performed in such a way that they provide an adequate description of the method's ability to estimate age.

The studies do not provide sufficient evidence to conclude whether there are differences in the development of wisdom teeth between populations from different regions.

Title:

Demirjian's development stages on wisdom teeth for estimation of chronological age: a systematic review

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Type of publication:

Systematic review

A review of a clearly formulated question that uses systematic and explicit methods to identify, select, and critically appraise relevant research, and to collect and analyse data from the studies that are included in the review. Statistical methods (meta-analysis) may or may not be used to analyse and summarise the results of the included studies.

Doesn't answer everything:

- Excludes studies that fall outside of the inclusion criteria
- No health economic evaluation
- No recommendations

Publisher:

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- Bjørn Anton Graff, Research leader, Diagnostics, Vestre Viken HF
- Sigrid Ingeborg Kvaal, Associate Professor, Institute of Clinical Dentistry, University of Oslo

Executive summary (English)

Background

Every year, young asylum seekers who are unaware of their age or cannot document their age arrive in Norway. To ensure that children receive their rights and that adults are not treated as children, it is necessary to estimate a chronological age. Evaluation of skeletal maturation of the hand and dental development has been used for age estimation of asylum seekers in Norway. These methods have been widely criticized for being imprecise, but currently no better methods have been put forward. In 2016, the Norwegian Institute of Public Health was assigned a national professional responsibility to evaluate and improve the methods (from 1.1. 2017 transferred with the Department of Forensic Sciences to Oslo University Hospital). The forensic expert group, in collaboration with the Knowledge Centre for the Health Services, conducted a systematic review of the evidence behind several of the medical age assessment methods.

The objective of this systematic review is to assess the scientific evidence on how mean chronological age is distributed in Demirjian's stages on wisdom teeth (third molar), and, if possible, to elucidate any variations between different populations.

We chose to concentrate on Demirjian's developmental stages in molars as this method has the strongest scientific documentation for estiamating age in children and young adults. In parallel, we have also conducted a systematic review of age estimation based on maturation stages of hand from the Greulich and Pyle atlas

Method

We searched for studies in the Cochrane Central Register of Controlled Trials (CENTRAL), MEDLINE, Embase and Google Scholar. End search date was May 2016. The literature search covered studies that use X-rays of teeth or hand, and CT or MRI of the clavicle, knee and ankle for age assessment of children and young people between 10 to 25 years. Two persons independently read title and summary of 10059 references. Of these, we found 589 potentially relevant publications for age estimation based on dental X-ray and two people independently considered these in full texts. We included 18 studies with results for children and young people that covered the whole or parts of the specified age range with data as mean chronological age with variance within each of Demirjian's stages on third molar. Two people independently considered the risk of bias in the studies based on the QUADAS-2 checklist and summarized this jointly.

Results

We found 18 cross-sectional studies using Demirjian's stages for molars to assess development of wisdom teeth, which presented results as mean age and standard deviation (variance) in tooth stages and provided information about the number of participants. The studies included from 209 to 3510 people with known chronological age. All studies included both boys and girls. Four studies were from China, two studies each from South Africa and Turkey, and one study each from Austria, Brazil, Britain, Canada, France, Iran, Malaysia, Malta, South Korea and Spain respectively. The age composition of the different studies varied considerably. The most narrow age range was from 15 years to 23 years (8 age cohorts) and the widest age range was from 4.1 years to 26.9 years (23 age cohorts). We considered that the majority of the studies had a high risk of a particular form of selection bias. Otherwise, the studies generally achieved low or unclear risk of bias based on our QUADAS-2 assessment.

Average chronological age for the different tooth stages varied considerably from study to study. We found that results from each study were highly influenced by the included age range and the number of individuals in each age group. This form of bias has previously been described as age mimicry. Age mimicry may strongly influence the observed mean age and standard deviation in each stage depending on the number of participants in each age group and the age span of the participants. Only a few of the 18 studies included an even number of individuals in the different age groups and an age range that was appropriate for all eight tooth stages.

We can highlight one study by Lee et al (2009) as an example of how the participants can be selected to describe the mean and standard deviation of age for tooth development stages of wisdom teeth in an adequate way. With this study, we demonstrate how one can use such data to describe the distribution of chronological age within each of the various stages for the purpose of age estimation. We also calculated prediction intervals (based on the mean age, standard deviation and the number of individuals for each stage), which gives a range of where the chronological age for an individual falls within, with a defined probability. We calculated such prediction intervals based on the results from Lee et al (2009) as an example. The calculations showed that the width of the 95 % prediction intervals for the various development stages ranged from 4.7 years to 6.8 years. For example, the mean age of individuals in stage E was 16.2 years and the estimated limits of the 95% prediction interval were 12.7 and 19.6 years.

Discussion

We found that the majority of the 18 included studies examining the mean age of Demirjian's stages on wisdom teeth, did include an uneven number of individuals in the different age cohorts. If you aim to describe how chronological age distributes within these stages, it is important to include an approximately equal number of people in each age group. In addition, the age range in such a study should be broad enough to cover all probable ages for the described stages. There is a particular problem with the stage H, as it is the final stage and also an important stage to describe whether a person is over or under 18 years. The upper ages of the enrolled participants in a study will strongly influence the mean age and the variance you observe for this stage. The higher the age included the higher the mean age and the standard deviation will be for stage H. There are several proposed strategies to solve this problem.

Variation observed between studies using Demirjian's stages on wisdom teeth has often been interpreted as differences in tooth development between populations and ethnicities. However, we consider age mimicry to be such a dominant source of variation in these studies that the scientific evidence is insufficient to conclude whether such differences exist.

Conclusion

The majority of studies we have summarized were conducted in such a way that we do not have confidence in the results. The number of participants in each age group and the total age range in the studies affect the results. If studies do not consider this, a bias called age mimicry occurs. Only one of the 18 studies prevented this phenomenon in their study design and could thus describe all eight Demirjian stages of wisdom teeth in an appropriate way. Based on this study, we calculated 95% prediction intervals for age in each development stage and found that these ranged from 4.7 to 6.8 years. Only when more studies with study designs that prevent bias due to age mimicry and with individuals from different regions, will it be possible to describe the age distribution in tooth stages in an appropriate way and conclude whether regional differences is of importance for tooth development.

Forord

Norske myndigheter overførte i 2016 det nasjonale ansvaret for medisinsk aldersestimering av enslige unge asylsøkere til Folkehelseinstituttet (fra 1.1. 2017 overført med Avdeling for rettsmedisinske fag til Oslo universitetssykehus). I samarbeid med Kunnskapssenteret i Folkehelseinstituttet har vi kartlagt det vitenskapelige grunnlaget for flere metoder som benyttes til medisinske aldersvurderinger.

Denne systematiske oversikten oppsummerer vitenskapelig dokumentasjon om samsvaret mellom kronologisk alder og Demirjians utviklingsstadier for visdomstenner med tanke på aldersestimering av tenåringer. Parallelt har vi utarbeidet en systematisk oversikt om samsvaret mellom kronologisk alder og skjelettalder basert på håndrøntgen vurdert mot Greulich & Pyle atlaset (1). Vi har utført ett litteratursøk som også inkluderer aldersvurdering ved bruk av CT eller MR av krageben, kne eller ankel. Vi har valgt å skrive disse to systematiske oversiktene som separate dokument, men bruker den samme teksten på tvers av dokumentene der det er relevant. Dette gjelder spesielt i introduksjonen, i beskrivelse av metodene og i deler av diskusjonen.

Prosjektgruppen har bestått av personer fra både Folkehelseinstituttet (FHI) og Oslo Universitetssykehus (OUS):

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Signe Flottorp	Gunn E. Vist	Veslemøy Rolseth
Avdelingsdirektør	*Seksjonsleder*	*Prosjektleder*

Innledning

Det finnes mange situasjoner der det kan råde tvil rundt en ung persons kronologiske alder, blant annet i tilknytning til barnearbeid, prostitusjon, idrett, seksuell lavalder, kriminell lavalder og asylsaker. I Norge er det primært usikkerhet om alder i saker der utlendingsmyndighetene er i tvil om asylsøkeren er mindreårig eller ikke. En enslig, mindreårig asylsøker er en asylsøker under 18 år som ikke har følge av foreldre eller andre med foreldreansvar. Ofte knytter det seg usikkerhet til disse asylsøkernes alder fordi mange land ikke systemer for registrering av fødsler, fordi mange unge asylsøkere ikke kjenner egen alder eller ikke kan dokumentere alderen. Alle som skal bli en del av det norske samfunnet må få en kronologisk alder. Denne er avgjørende for personens krav om blant annet beskyttelse, helsehjelp, omsorg og utdannelse.

De europeiske landene har ulik praksis for hvordan medisinske aldersvurderinger og aldersfastsettelse gjennomføres (2). I Norge er det Utlendingsdirektoratet (UDI) som fastsetter alder. Dersom det mangler dokumenter som bekrefter søkernes alder eller identitet, er det aktuelt å tilby søkerne en medisinsk aldersestimering. Når medisinsk aldersvurdering er gjennomført inngår det som et underlagsmateriale for aldersfastsettelsen.

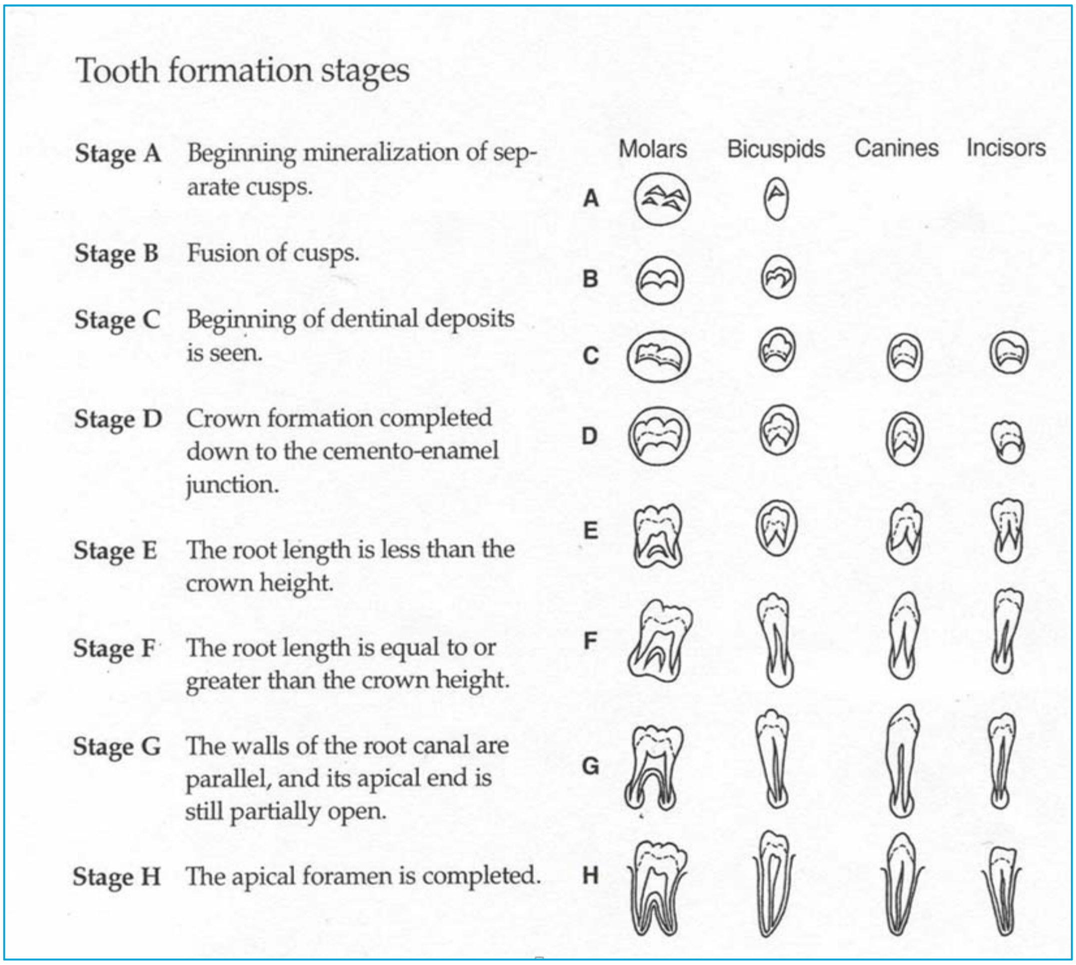
Fra 1. januar 2016 fikk Folkehelseinstituttet i oppdrag fra Helse- og omsorgsdepartementet å ha et overordnet medisinskfaglig ansvar for de medisinske aldersvurderingene. Bakgrunnen for dette var at Utlendingsdirektoratet selv ikke har faglig kompetanse til å vurdere kvaliteten i de benyttede metodene eller til å drive forsknings- og utviklingsarbeid. Det var derfor et ønske om at ansvaret skulle legges hos et offentlig medisinskfaglig miljø med bred kompetanse innen sakkyndigvirksomhet og forskning. Som et ledd i arbeidet for å bygge opp kompetanse innen medisinske aldersvurderinger, ble det innledet et samarbeid mellom det rettsmedisinske miljøet og Kunnskapssenteret for helsetjenesten i Folkehelseinstituttet. Vi gjennomfører kunnskapsoppsummeringer for flere av de mest sentrale metodene som ligger til grunn for dagens praksis for medisinske aldersvurderinger i Norge og Europa.

Det skjer en rekke biologiske endringer i takt med at et menneske vokser og utvikles. Vurderingen av spesifikke utviklingsstadier danner grunnlag for medisinske aldersvurderinger. De mest brukte metodene internasjonalt er basert på vurdering av skjelett- (som oftest hånd) og tannutvikling. Hos barn og voksne kan man ut fra et røntgenbilde av tennene vurdere tannutvikling opp mot et graderingssystem som igjen vil gi et estimat av kronologisk alder (3). Det finnes ulike system for å gradere tannutvikling. Det som primært skiller disse er hvor mange utviklingstrinn som beskrives. På grunn av disse ulikhetene er det ikke mulig å sammenligne systemene. Fordi det foreligger mest publisert litteratur på gradering av tredje molar basert på Demirjians utviklingsstadier valgte vi å fokusere på dette graderingssystemet.

Formålet med denne systematiske oversikten er å få en oversikt over den vitenskapelige dokumentasjonen om hvordan kronologisk alder fordeler seg i Demirjians utviklingsstadier av tredje molar, og å belyse eventuelle variasjoner mellom ulike populasjoner. Denne systematiske oversikten vil sammen med de andre kunnskapsoppsummeringene inngå i et grunnlag for en videre drøfting og anbefaling av hvordan medisinske aldersvurderinger bør gjennomføres i Norge.

Beskrivelse av Demirjians utviklingsstadier

I 1973 publiserte Demirjian, Goldstein og Tanner (3) en studie basert på 2928 franskkanadiske barn, 1446 gutter og 1482 jenter, i alderen 2-20 år. Hensikten med denne studien var å finne en metode for å vurdere tannutvikling i forhold til alder. På røntgenbilder undersøkte de mineraliseringen av 7 tenner (første fortann, andre fortann, hjørnetann, første premolar, andre premolar, første molar og andre molar) i venstre del av underkjeven og anga en tallverdi for hvert utviklingsstadium av hver tanntype. Summen av tallverdiene ble konvertert til individets tannalder. I ettertid er metoden også brukt for å estimere alder ut fra tannutvikling.



Figur 1: Demirjians tannutviklingsstadier er delt inn i åtte stadier, A-H, hvor de fire første er kronestadier og de fire siste er rotstadier (3).

Demirjians åtte utviklingsstadier var basert på Gleiser og Hunts 15 utviklingstrinn (4) med ett, to eller tre beskrivende kriterier per stadium som alle primært er basert på endring i form og størrelse. Tallverdien for gutter og jenter var forskjellige og ble holdt avskilt. De fant ikke signifikante forskjeller mellom høyre og venstre side av underkjeven. Den venstre siden ble valgt som standard.

Bruk av Demirjians utviklingsstadier for aldersestimering

Tennene utvikler seg i en relativt ordnet rekkefølge og kan dermed brukes til å estimere kronologisk alder. Vurdering av tannutvikling inngår som et element i den medisinske aldersvurderingen av unge enslige asylsøkere i mange europeiske land (2). I Norge har en slik tannundersøkelse fram til nylig bestått både av avlesning av røntgenbilde av tennene, et såkalt orthopantomogram (OPG), og en klinisk undersøkelse av tennene. Høsten 2016 ga Folkehelseinstituttet råd om at denne kliniske undersøkelsen ikke bør videreføres. Fra 1. januar 2017 skal tannutviklingsundersøkelser som grunnlag for medisinsk aldersvurdering kun baseres på røntgenbaserte vurderinger.

Figur 2: Et orthopantomogram (OPG) er et panoramarøntgenbilde som viser hele tannsettet. Kilde: https://gympieradiology.com/services/dental

Et orthopantomogram viser alle tennenes utviklingsstadium. For de fleste unge enslige asylsøkerne er det utviklingen av visdomstannen som er av vesentlig betydning. Dette er fordi de øvrige tennene vanligvis er ferdig utviklet ved ca. 15-16 års alder. Det finnes mange måter å gradere tennenes utviklingsstadier på. Felles for disse er at man finner frem til en tannalder basert på hvor langt utvalgte tenner er kommet i mineraliseringsprosessen av krone og rot.

Valideringsstudier av Demirjians utviklingsstadier på visdomstenner

Opprinnelig inkluderte metoden til Demirjian og medarbeidere ikke gradering av tredje molar. Mincer og medarbeidere (5) adopterte derimot graderingene av tannutvikling for molarene for bruk på visdomstenner og anga en alder for hvert utviklingsstadium. I dag finnes det rikelig med studier som har publisert data for Demirjians åtte utviklingstrinn gradert på tredje molar, slik at det nå er den mest brukte graderingen også for denne tannen. Nummerering for visdomstenner er ifølge det internasjonale systemet FDI slik; 18 (tann til høyre i overkjeve), 28 (tann til venstre i overkjeve), 38 (tann til venstre i underkjeve) og 48 (tann til høyre i underkjeve).

Man må derimot være oppmerksom på at tredje molar er den mest variable av alle tenner når det gjelder utvikling og frembrudd. Det er også en stor andel av befolkningen som har retinerte visdomstenner (hindret frembrudd). I tillegg er dette tenner som ikke alltid utvikles (agenesi) eller de blir fjernet av medisinske årsaker.

Metode

Vi har systematisk oppsummert studier som vurderer samsvaret mellom kronologisk alder og utviklingsstadier for visdomstenner basert på Demirjians metode for aldersestimering (3), samt kartlagt studier av andre aldersestimeringssystem basert på tannrøntgen av ungdom og unge voksne. Siden vi arbeidet parallelt med flere systematiske oversikter om aldersestimering, har vi utført ett felles litteratursøk etter studier som har undersøkt aldersestimeringsmetoder basert på røntgen av tenner eller hånd, samt CT eller MR av krageben, kne eller ankel. Arbeidet baserte seg på Kunnskapssenterets metodebok «Slik oppsummerer vi forskning» (6), med følgende spesifikasjoner:

Inklusjonskriterier

Studiedesign:	Vi inkluderte studier som hadde sammenlignet utviklingsstadier basert på røntgenbilder av tenner med kjent kronologisk alder
Populasjon:	Personer med kjent alder mellom 10 og 25 år
Index test:	Graderingssystem av jeksler basert på røntgen av tenner (ortopantomogram), slik som beskrevet i Demirjians metode
Referansetest:	Kjent kronologisk alder
Utfall:	Fordeling av kronologisk alder etter utviklingsstadier for den aktuelle metoden

Eksklusjonskriterier:

- Studier som ikke er presentert i fulltekst (konferanseabstrakt og postere)
- Studier som har inkludert døde mennesker (levninger etc)
- Indekstester som involverer å ta ut/fjerne tenner eller deler av tenner
- Studier som har inkludert færre enn 50 personer mellom 10 og 25 års alder

Litteratursøking

Bibliotekar Gyri Hval Straumann gjennomførte litteratursøket og Marit Johansen fagfellevurderte dette. Det ble utført ett felles søk for studier som utførte aldersestimering basert på røntgen av tenner eller hånd, samt CT eller MR av krageben, kne eller ankel til aldersestimering i den angitte aldersspennet. Appendix 1 inneholder søkestrategien.

Vi søkte etter primærstudier uten tids- og språkbegrensing i følgende databaser:

- Cochrane Central Register of Controlled Trials (CENTRAL)
- MEDLINE (Ovid) og Pubmed [sb]
- Embase (Ovid)
- Google Scholar

I tillegg søkte vi i registre over pågående studier som beskrevet i Appendix 1.

Artikkelutvelging

To prosjektmedarbeidere leste og vurderte alle identifiserte titler og sammendrag uavhengige av hverandre. Vi benyttet web-programmet Rayyan til å håndtere referansene i utvelgelsen (7) og fordelte arbeidet mellom oss (PSD, KYD, AM, GHS, GEV). Vi markerte hvilke av de potensielt relevante artiklene som omhandlet aldersestimering basert på røntgen av tenner eller hånd, eller CT eller MR av kragebein eller ankel. De utvalgte referansene for aldersestimering basert på tannrøntgen ble deretter vurdert i fulltekst av to personer uavhengige av hverandre (PSD, KYD, AM, GEV, MSM) ut fra inklusjonskriteriene beskrevet ovenfor. Prosjektgruppen har lest og vurdert studier på engelsk, skandinaviske språk, kinesisk, japansk og polsk. Vi har fått hjelp av kolleger på Folkehelseinstituttet til å vurdere studier på fransk, tysk, spansk, portugisisk og italiensk. Vi har fått hjelp av andre bekjente til å vurdere studier på hebraisk.

I tillegg vurderte vi om de relevante artiklene presenterte data på en slik måte at de kunne inngå i våre analyser. Dataene måtte være presentert med gjennomsnitt og standard avvik av kronologisk alder i utviklingsstadier for tredje molar basert på Demirjians utviklingsstadier for alle eller noe av stadiene fra A-H. Studier av andre aldersestimeringsmetoder på tannrøntgen enn de som brukte Demirjians utviklingsstadier ble kartlagt.

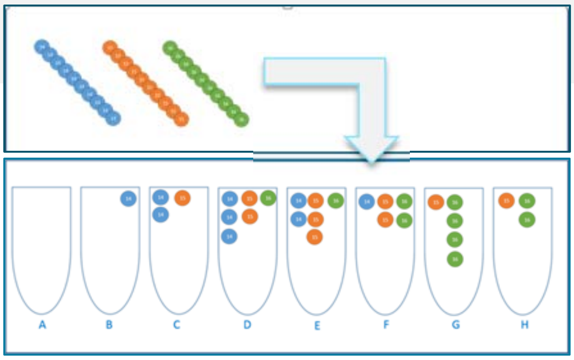
Kvalitetsvurdering og dataekstraksjon

Vi vurderte den metodologiske kvaliteten i inkluderte studier ved hjelp av QUADAS-2 metoden (8). VR vurderte alle de inkluderte studiene og AM, MSM og GEV omtrent 1/3 hver, før vurderingene ble sammenlignet og eventuell uenighet løst ved diskusjon. QUADAS-2 er en sjekkliste for å vurdere anvendbarhet og risiko for systematiske skjevheter i valideringsstudier av diagnostiske tester. Vi anser at QUADAS-2 er den sjekklisten for kvalitetsvurdering som passer best for denne systematiske oversikten. Vi tilpasset vurderingen av risikoen for systematiske skjevheter som beskrevet under.

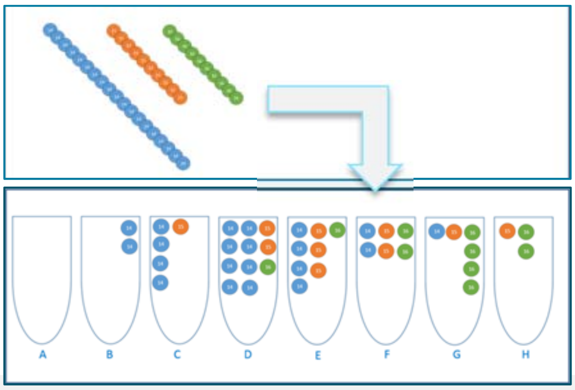
QUADAS-2 har fire domener: Utvelgelse av deltakere; Indekstest; Referansetest; og Flyt og tidsaspekt. I metoden er det angitt støttespørsmål som benyttes i vurderingen. Det første domenet vurderer om det er risiko at deltakere er valgt slik at resultatene ikke blir representative for populasjonen de kommer fra (seleksjonsskjevhet). Det andre domenet, «Indekstest», vurderer om det kan være risiko for systematisk skjev vurdering ved gjennomføring og tolkning av indekstesten – her spesielt om de som vurderte røntgenbildet hadde kjennskap til deltakerens alder. Siden kjent alder var et inklusjonskriterium vurderte vi at alle studiene hadde lav risiko for systematisk skjevheter for domenet «Referansetest». I domenet «Flyt og tidsaspekt» vurderes det om gjennomføring av studien og analysene er utført på en slik måte at systematiske skjevheter ikke introduseres underveis.

Ulikt antall deltakere for ulike årskull og aldersspennet for de inkluderte deltakerne i en studie gir opphav til fenomenet aldersmimikering (9) (illustrert i figur 3).

Aldersmimikering oppstår når individene som er inkludert i en studie ikke har en jevn aldersfordeling, enten ved at visse aldersgrupper er overrepresentert eller at nedre og/eller øvre inkluderte alder er slik at det påvirker resultatene. Problemet kan oppstå når man forsøker å skildre en variabel (her kronologisk alder) ved å fordele individene på diskrete stadier (her utviklingsstadium) og deretter beskriver variabelen per stadium.



La oss si man gjør en studie som inkluderer 30 individer, fordelt likt på tre aldersgrupper: 14 år (blå), 15 år (oransje) og 16 år (grønn). Disse kan fordele seg i åtte mulige utviklingsstadier angitt med bokstavene A til H. I den tenkte studien fordeler aldersgruppene seg i de åtte stadiene som i figuren til venstre.



Så bestemmer man seg for å doble antallet fjortenåringer i studien, men beholder antall femten- og sekstenåringer. Utgangspunktet er illustrert på bildet til venstre. Illustrasjonen viser et eksempel på hvordan disse individene kan fordele seg på stadiene.

Hvis vi betrakter stadium D i de to eksemplene er det åpenbart at disse to oppsettene vil gi svært ulik gjennomsnittsalder i stadiet (fjortenåringene blir mer dominerende i det nederste bildet). I tillegg vil gjennomsnittsverdien og standardavvik påvirkes av at det ikke finnes individer som er 13 år eller yngre, samt 17 år og eldre. For å unngå effekten av aldersmimikering i denne typen studier må man undersøke tilstrekkelig mange individer som er jevnt fordelt i kronologisk alder og at aldersspennet dekker de utviklingsstadiene man er interessert i.

Figur 3: Illustrasjon av fenomenet aldersmimikering (engelsk: age mimicry) (9).

Aldersmimikering er en form for seleksjonsskjevhet, forstått som forvrengning av resultatene som følge av fremgangsmåten for innsamling av prøver. I QUADAS-2 sjekklisten faller fenomenet aldersmimikering under kategorien spektrumbias – et underpunkt under domenet «Utvelgelse av deltakere» (8). Vi vurderte derfor studiene opp mot to ekstra spørsmål: 1) Om det var likt antall deltakere i hvert årskull, og 2) om alders-spennet var relevant for de analyserte utviklingsstadiene. Siden aldersmimikering kan ha stor innvirkning på resultatene fra studiene har vi vurdert dette forholdet separat for å tydeliggjøre den relevante informasjonen.

VR, AM og GEV hentet ut informasjon om populasjon og gjennomføring, og informasjonen ble sjekket av en annen person. KYD hentet ut data fra studiene og VR, AM og GEV dobbeltsjekket uttrekket. Informasjonen vi hentet ut var følgende:

- Hvor studien var gjennomført, og eventuelt informasjon om etnisitet
- Datainnsamlingsperiode
- Deltakernes antall, kjønn og alder
- Studiedesign
- Informasjon om alderestimeringsmetoden
- Formålet med studien
- Metode for å velge ut deltakerne

Vi hentet ut følgende data (avhengig av hvordan resultatene var oppgitt):

- Gjennomsnitt og standardavvik (SD) av kronologisk alder (CA) for gitte utviklingsstadier (tannstadier).
- Antall observasjoner innen hvert utviklingsstadium.
- Antall individer observert for ulike årskull (dette ble ikke oppgitt for alle studier).

Dersom studiene ikke hadde oppgitt antall personer som ble observert i hvert utviklingsstadium ble studien ekskludert, men er presentert i listen over relevante datasett (Appendix 3).

Analyser

For studier som kun oppga kvantiler av kronologisk alder (f.eks. 5 % og 95 % kvantilene), og ikke standardavvikene (SD), beregnet vi SD ved bruk av normalantagelse.

Utfallsmål i analysene

Det er ett primært utfall i dette prosjektet:

- Gjennomsnittlig kronologisk alder for hvert gitte tannstadium.

Gjennomsnittlig kronologisk alder for hvert gitte tannstadium vil være knyttet til å anslå kronologisk alder (prediksjon) for en person som har et observert tannstadium (praksis). Konfidensintervallene (95 % KI) for gjennomsnittsverdiene for kronologisk alder for tannstadiene uttrykker hvor presist gjennomsnittsalderen i populasjonen er estimert. Gjennomsnittsverdien vil variere hvis man hadde gjort studien flere ganger for samme populasjon. Konfidensintervallet angir usikkerheten på estimatet av gjennomsnittlig kronologisk alder i populasjonen. Det vil si at dersom samme studie hadde vært utført med samme antall individer på samme populasjon, ville populasjonsgjennomsnittet havnet innenfor disse tallverdiene med 95 % sannsynlighet (eller 95 av 100 ganger). Jo smalere konfidensintervall jo mer presist vil estimatet på populasjonsgjennomsnittet være. Konfidensintervallet blir generelt bredere dersom estimatet er basert på færre observasjoner.

Statistisk utførelse

Vi beregnet konfidensintervallene ved bruk av statistikkprogrammet R (versjon 3.3.2) med R-pakken "metafor". Denne pakken utfører også inferens om heterogeniteten mellom studiene.

Vurdering av heterogenitet

For å vurdere statistisk heterogenitet mellom studiene, benyttet vi p-verdien fra heterogenitetstesten (basert på «Cochran's Q» testobservator), og andel av den totale variasjonen som kan forklares av heterogenitet ved I^2. Merk at dersom p-verdien fra testen er lav (f.eks. $<0,1$), indikerer dette at den observerte forskjellen mellom studiene er større enn forskjellen man forventer ved tilfeldig variasjon mellom resultatene i studiene. I^2 statistikken anvendes for å kvantifisere nivået av statistisk heterogenitet. En viktig konsekvens av vurderingen om heterogenitet er at der det er høy grad av heterogenitet mellom studiene, så må det samlede resultatet fra en eventuell metaanalyse tolkes med forsiktighet.

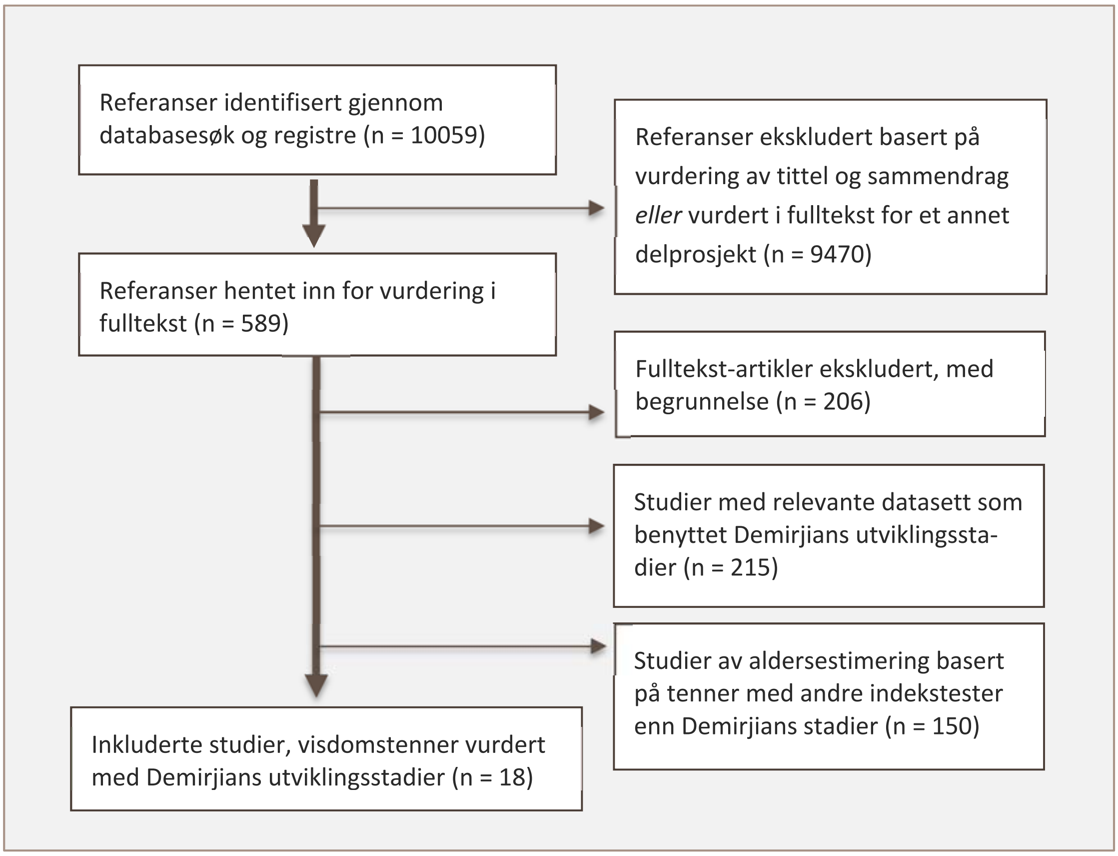
Etikk

Vi har valgt å ikke ha en drøfting av etikk i denne rapporten. De etiske aspektene ved aldersestimering basert på Demirjians utviklingsstadier av visdomstenner er spesielt knyttet til hvordan metoden anvendes. Dette drøftes i andre publikasjoner (10-12).

Resultater

Resultater av litteratursøket

Søket i elektroniske databaser og registre fram til mai 2016 ga 10059 antatt unike referanser. Vi vurderte at 9470 ikke var relevante eller de ble vurdert i fulltekst for ett av de andre delprosjektene. Vi hentet inn 589 publikasjoner i fulltekst som vi antok kunne være relevante for aldersestimering basert på tannrøntgen. Vi inkluderte 18 studier, se flytskjema i figur 4. Håndtering av de resterende referansene beskrives under.



Figur 4: Flytskjema for søkeresultater og håndtering av referanser

Beskrivelse av de inkluderte studiene

Vi inkluderte 18 artikler som hadde benyttet Demirjians utviklingsstadier på visdomstenner fordelt på kronologisk alder. Tabell 1 gir en enkel beskrivelse av de inkluderte studiene. Ytterligere beskrivelser finnes i Appendix 2.

Tabell 1: Beskrivelse av de inkluderte studiene

Forfatter id (referanse)	Land	Etnisitet* eller region	Antall	Antall gut-ter/jenter	Aldersspenn
Boonpitaksathit 2011 (13)	Storbritannia	London	1223	453/770	12,6 - 24,9 år
Elshehawi 2016 (14)	Malta	-	1593	742/851	4 - 26 år
Guo 2014 (15)	Kina	Nord	3512	1255/2257	11 - 24 år
Guo 2015 (16)	Kina	Nord	3212	1551/1661	5 - 25 år
Johan 2012 (17)	Malaysia	Nord	1080	540/540	14 - 25 år
Karadayi 2015 (18)	Tyrkia	Kaukasiere	784	379/405	8 - 23 år
Karataş 2013 (19)	Tyrkia	Øst	832	424/408	6 - 16 år
Lee 2009 (20)	Sør-Korea	-	3301	1610/1691	4 - 26 år
Li 2012 (21)	Kina	Vest	2078	989/1089	5 - 23 år
Lopez 2013 (22)	Brasil	São Paulo	659	280/379	15 - 23 år
Meinl 2007 (23)	Østerrike	Østerisk	610	275/335	12 - 24 år
Olze 2006 (24)	Sør-Afrika	«Black»	595	474/121	10 - 26 år
Olze 2010 (25)	Canada	Inuitt	605	258/347	11 - 29 år
Olze 2012 (26)	Sør-Afrika	«Black»	553	437/116	10 - 26 år
Prieto 2005 (27)	Spania	-	1054	462/592	14 - 21 år
Rougé-Maillart 2011 (28)	Frankrike	«White»	209	94/115	11 - 26 år
Zandi 2015 (29)	Iran	-	2536	982/1554	5 - 26 år
Zeng 2010 (30)	Kina	Sør (Han)	3100	1200/1900	4,1 – 26,9 år

* Basert på eventuell betegnelse presentert av artikkelforfatterne.

Alle artiklene var publisert relativt nylig, fra 2005 til 2016. Det var fire studier fra Kina, to studier hver fra Tyrkia og Sør-Afrika, og én studie fra henholdsvis Brasil, Canada, Frankrike, Iran, Malta, Malaysia, Spania, Storbritannia, Sør-Korea og Østerrike. Alle studiene inkluderte begge kjønn. Det var stor variasjon i antall deltakere i studiene, fra 209 til 3512 personer, og i aldersspennet på deltakere. Det smaleste aldersspennet var fra 15 år til 23 år (totalt 8 årskull) i studien til Lopez 2013 (22), og det bredeste aldersspennet var på 4,1år til 26,9 år (totalt 23 årskull) i studien til Zeng 2010 (30).

Andre studier vurdert fra fulltekst

Relevante datasett som benyttet Demirjians metode i aldersestimering

Etter at resultatene i denne rapporten var ferdig analysert, fant vi to artikler som oppfylte alle inklusjons- og eksklusjonskriteriene (31, 32). Vi vurderer at inklusjon av disse to studiene ikke vil forandre konklusjonene i denne systematiske oversikten.

Vi identifiserte ytterligere 213 studier som hadde samlet inn data både på kronologisk alder og utviklingsstadier eller tannalder basert på Demirjians metode. I tillegg oppfylte studiene kriteriene for populasjonen, det vil si minst 50 studiedeltakere i alderen 10-25 år. Disse studiene presenteres kort i Appendix 3. I Appendix 3 skiller vi ikke mellom studier som benyttet Demirjians originale system basert på de første sju tenner, vurdering av visdomstenner eller en kombinasjon av ulike tenner. Studiene i Appendix 3 ble ikke inkludert i analysene enten fordi studiene ikke hadde data på vurdering av visdomstenner eller fordi artikkelen ikke presenterte relevante tall eller hadde rett format på dataene for våre planlagte analyser. Noen av disse studiene var analysert med tanke på en annen problemstilling enn vår, men vi har dem med i vedlegg fordi de har innsamlet relevante data. Appendix 3 inneholder en oversikt over disse studiene.

Relevante datasett som benyttet andre indeks-tester enn Demirjians metode for å vurdere tannalder eller tannutviklingsstadier

Vi identifiserte ytterligere 150 studier hadde validert metoder for aldersestimering med utgangspunkt i røntgenbilder av tenner som benyttet andre indeks-tester enn Demirjians stadier. I tillegg oppfylte studiene kriteriene for populasjonen med minst 50 studiedeltakere i alderen 10-25 år. Appendix 4 gir en oversikt over disse studiene.

Ekskluderte studier

Av de 589 referansene som ble innhentet i fulltekst, ekskluderte vi 206 etter vurdering mot inklusjons- og eksklusjonskriteriene. Se Appendix 5 for liste over disse ekskluderte studiene med begrunnelse for eksklusjon. Blant disse var det også 8 artikler som ikke ble hentet inn fordi de var vanskelig å skaffe til veie eller svært dyre i innkjøp.

Kvalitetsvurdering av inkluderte studier basert på QUADAS-2

Tabell 2 viser kvalitetsvurdering av de inkluderte studiene basert på QUADAS-2 sjekklisten (8). Vi vurderte at åtte av studiene hadde lav risiko for seleksjonsskjevhet, ni studier hadde uklar risiko og én studie hadde høy risiko for at utvalget ikke var representativt. Kun seks av atten studier spesifiserte at vurderingen av indekstesten var blindet, mens for de andre studiene var dette ikke omtalt (uklar risiko for systematisk skjevhet). Siden kjent kronologisk alder (referansetest) var et inklusjonskriterium vurderte vi at alle studiene hadde lav risiko for systematisk skjevhet i referansetesten. For «flyt og tidsaspekt» hadde én av studiene høy risiko for skjevheter siden de ekskluderte personer hvor alle visdomstenner var fullt utviklet (stadium H). Tre av studiene hadde uklar risiko for denne type skjevheter siden dette var uklart i metodebeskrivelsen.

Alle studiene oppga aldersspennet til de inkluderte deltakerne. Dette gir oss mulighet til å gjøre en vurdering av om vi tror fordelingen av kronologisk alder for gitte utviklingsstadier kan bli forskjøvet på grunn av aldersmimikering. Seks av de atten studiene oppga ikke antall deltakere per inkluderte årskull og vi kan derfor ikke vurdere om fordeling i gruppene kan bidra til at resultatene påvirkes av aldersmimikering. De resterende 12 studiene oppga dette antallet. For 16 av studiene varierer antall inkluderte per årskull i stor grad. Én av studiene (17) hadde likt antall personer i hvert årskull, men hadde 14-åringer som yngste alder, dermed kan den ikke beskrive de første utviklingstrinnene av tredje molar. Kun én av studiene, av Lee og medarbeidere (20), hadde en tilnærmet jevn aldersfordeling av de inkluderte deltakerne og samtidig inkludert et bredt aldersspenn, fra 4 til 26 år. Studien er også stor, med totalt 3301 deltakere.

Tabell 2: Kvalitetsvurdering av de inkluderte studiene basert på QUADAS-2 sjekklisten i fire domener, samt ekstra vurdering for risiko for aldersmimikering.

	Domener for kvalitetsvurdering basert på QUADAS-2				
	Seleksjonsskjevhet				
Forfatter, år	Utvelgelse av deltakere	Alders-mimikering	Tolkning av indekstesten	Referanse-test	Flyt og tidsaspekt
Boonpitaksathit 2011	?	?	?	+	+
Elshehawi 2016	+	?	+	+	+
Guo 2014	?	−	?	+	+
Guo 2015	+	−	+	+	+
Johan 2010	?	−	?	+	+
Karadayi 2015	?	?	?	+	+
Karataş 2013	+	−	?	+	+
Lee 2009	?	+	?	+	+
Li 2012	?	−	+	+	+
Lopez 2013	?	−	+	+	+
Meinl 2007	+	−	?	+	+
Olze 2006	?	−	?	+	?
Olze 2010	+	−	?	+	?
Olze 2012	?	−	+	+	?
Prieto 2005	?	?	?	+	+
Rouge-Maillart 2011	+	?	?	+	−
Zandi 2015	+	−	+	+	+
Zeng 2010	+	?	?	+	+

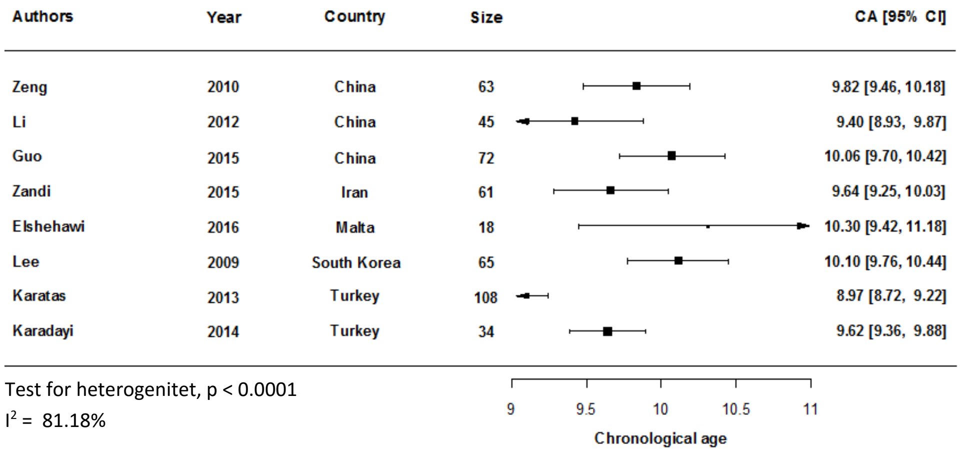
+ *Lav risiko,* ? *uklar risiko og* − *høy risiko for systematiske skjevheter i studien.*
For ytterligere detaljer om gjennomføring av studiene, se beskrivelser i Appendix 2.

Gjennomsnittlig kronologisk alder i Demirjians utviklingsstadier

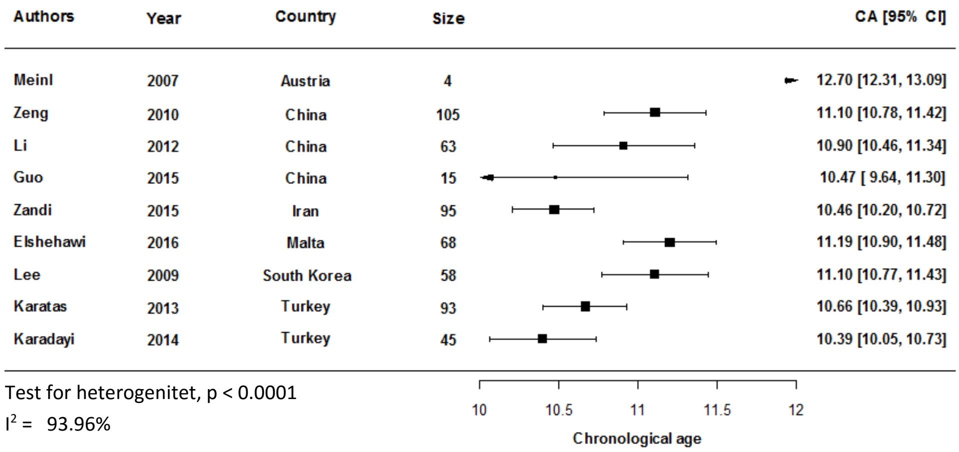
Alle de inkluderte studiene viste beregnet gjennomsnittlig kronologisk alder i observerte utviklingsstadier for visdomstenner etter Demirjians gradering av molarer. På grunn av ulikt aldersspenn i studiene er det ulikt antall studier for de ulike utviklingsstadiene.

Vi vurderte først om det var hensiktsmessig å sammenfatte resultatene fra disse studiene som samlede estimat i metaanalyser. Gjennom QUADAS-2 vurderingene hadde vi vurdert at elleve av studiene hadde høy risiko for at resultatene kan være påvirket av aldersmimikering, mens for seks studier var det uklar risiko for aldersmimikering (informasjon mangler for å gjøre vurderingen). Kun én studie sto fram med lav risiko for aldersmimikering. Vi mener at effekten av aldersmimikering for flertallet av studiene er så stor at det er høy risiko for at gjennomsnittet og spredning av kronologisk alder i hvert utviklingsstadium blir feil. For eksempel vil et for snevert aldersspenn gi for lave standardavvik. Vi vurderte derfor at det ikke er hensiktsmessig å slå resultatene sammen i metaanalyser, men vi presenterer funnene grafisk i plottene. Figurene 5-12 viser resultatene separat for hvert utviklingsstadium A-H for gutter, mens figur 13-20 viser det samme for jenter. For hver studie angis antall observasjoner, den gjennomsnittlige kronologiske alderen for hvert utviklingsstadium og kjønn, samt usikkerheten i estimatene for populasjonsgjennomsnittet som 95 % KI. Dette presenteres både som et punktestimat med en vannrett linje for 95 % KI og som tall til høyre i figurene.

Figur 5
Gutter
A



Figur 6
Gutter
B



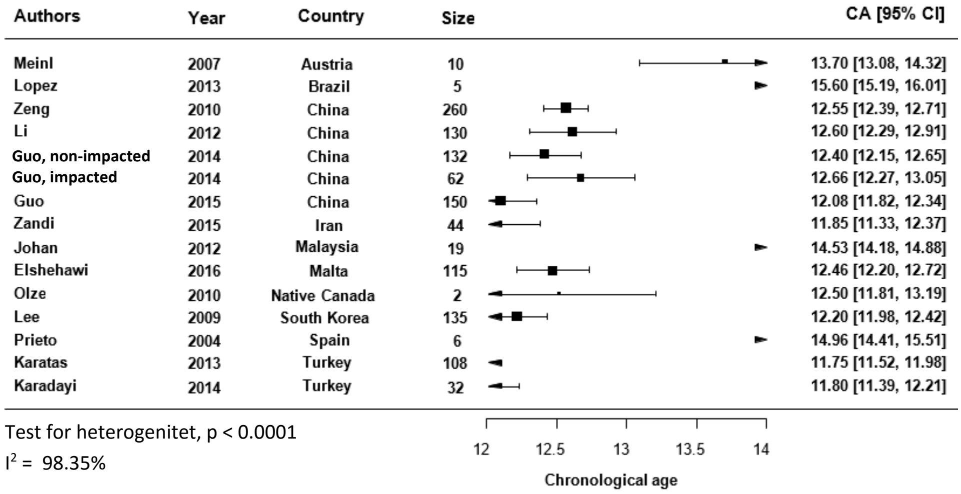
Figurer 5-6: Gjennomsnittlig kronologisk alder når visdomstann 38 er i utviklingsstadiene A og B for gutter.

CA: kronologisk alder; 95% CI: 95 % konfidensintervall

Figur 7

Gutter

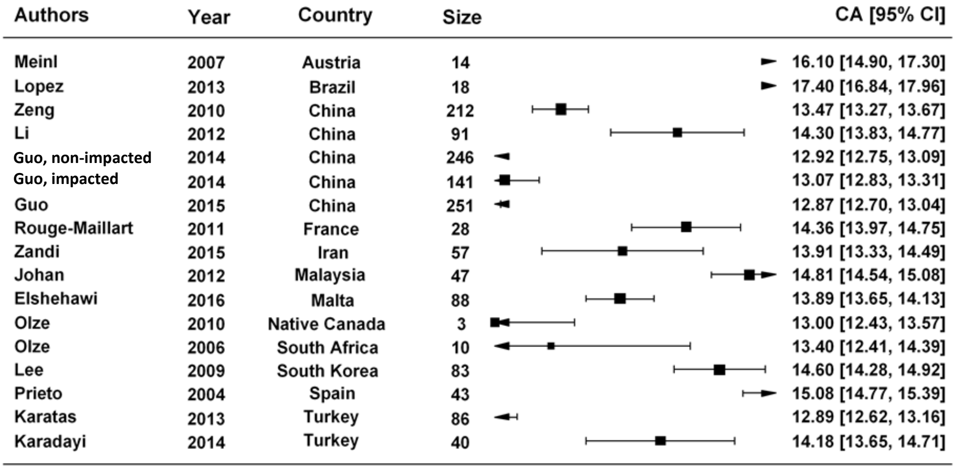
C



Figur 8

Gutter

D



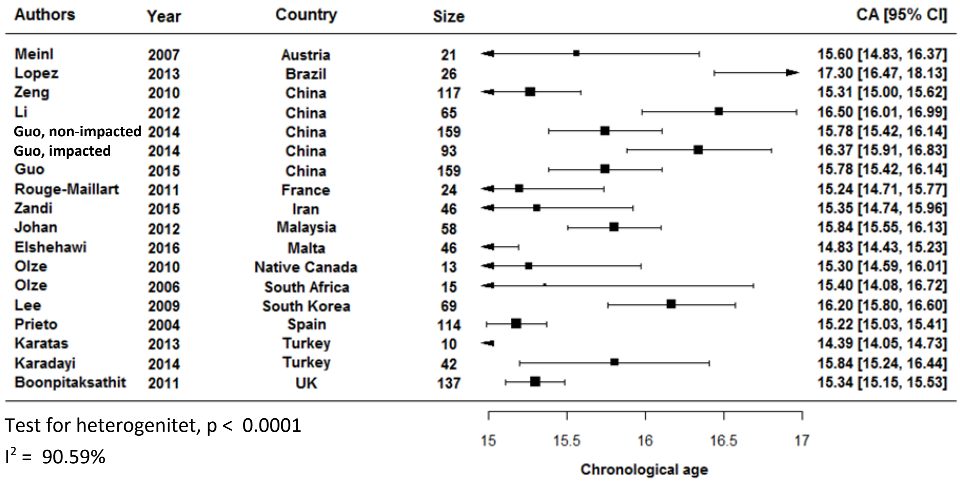
Test for heterogenitet, p < 0.0001

I^2 = 98.35%

Figur 9

Gutter

E



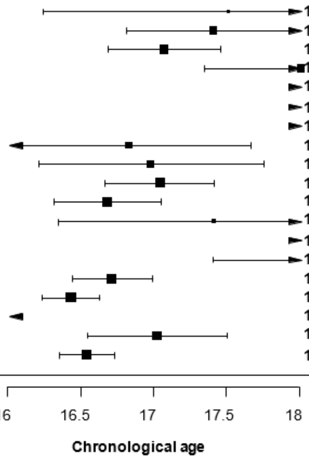
Figurer 7-9: Gjennomsnittlig kronologisk alder når visdomstann 38 er i utviklingsstadiene C, D og E for gutter.

CA: kronologisk alder; 95% CI: 95 % konfidensintervall

Figur 10

Gutter F

Authors	Year	Country	Size	CA [95% CI]
Meinl	2007	Austria	16	17.50 [16.23, 18.77]
Lopez	2013	Brazil	33	17.40 [16.80, 18.00]
Zeng	2010	China	68	17.06 [16.67, 17.45]
Li	2012	China	54	18.00 [17.33, 18.67]
Guo, non-impacted	2014	China	67	19.06 [18.32, 19.80]
Guo, impacted	2014	China	39	19.23 [18.26, 20.20]
Guo	2015	China	66	18.95 [18.24, 19.66]
Rouge-Maillart	2011	France	24	16.82 [15.99, 17.65]
Zandi	2015	Iran	39	16.97 [16.20, 17.74]
Johan	2012	Malaysia	59	17.03 [16.65, 17.41]
Elshehawi	2016	Malta	40	16.67 [16.30, 17.04]
Olze	2010	Native Canada	11	17.40 [16.34, 18.46]
Olze	2006	South Africa	51	18.60 [17.91, 19.29]
Olze	2012	South Africa	20	18.43 [17.40, 19.46]
Lee	2009	South Korea	99	16.70 [16.42, 16.98]
Prieto	2004	Spain	177	16.42 [16.22, 16.62]
Karatas	2013	Turkey	3	15.00 [15.00, 15.00]
Karadayi	2014	Turkey	46	17.01 [16.53, 17.49]
Boonpitaksathit	2011	UK	131	16.53 [16.34, 16.72]



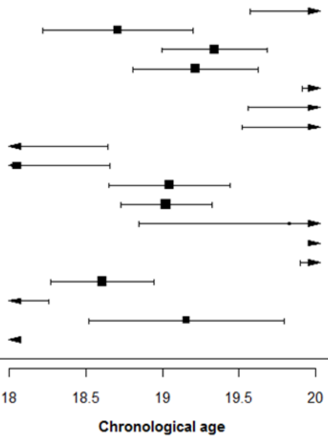
Test for heterogenitet, $p < 0.0001$

$I^2 = 94.00\%$

Figur 11

Gutter G

Authors	Year	Country	Size	CA [95% CI]
Meinl	2007	Austria	56	20.10 [19.55, 20.65]
Lopez	2013	Brazil	65	18.70 [18.22, 19.18]
Zeng	2010	China	110	19.32 [18.99, 19.65]
Li	2012	China	115	19.20 [18.80, 19.60]
Guo, non-impact.	2014	China	96	20.49 [19.88, 21.10]
Guo, impacted	2014	China	62	20.21 [19.54, 20.88]
Guo	2015	China	88	20.06 [19.50, 20.62]
Rouge-Maillart	2011	France	17	17.84 [17.05, 18.63]
Zandi	2015	Iran	37	18.05 [17.45, 18.65]
Johan	2012	Malaysia	105	19.03 [18.64, 19.42]
Elshehawi	2016	Malta	43	19.01 [18.72, 19.30]
Olze	2010	Native Canada	7	19.80 [18.84, 20.76]
Olze	2006	South Africa	49	21.10 [20.48, 21.72]
Olze	2012	South Africa	23	20.73 [19.87, 21.59]
Lee	2009	South Korea	90	18.60 [18.27, 18.93]
Prieto	2004	Spain	76	17.92 [17.58, 18.26]
Karadayi	2014	Turkey	41	19.14 [18.52, 19.76]
Boonpitaksathit	2011	UK	71	17.56 [17.29, 17.83]



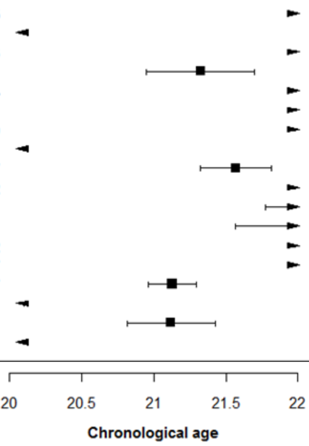
Test for heterogenitet, $p < 0.0001$

$I^2 = 95.05\%$

Figur 12

Gutter H

Authors	Year	Country	Size	CA [95% CI]
Meinl	2007	Austria	105	22.40 [22.06, 22.74]
Lopez	2013	Brazil	89	19.50 [19.07, 19.93]
Zeng	2010	China	213	22.72 [22.42, 23.02]
Li	2012	China	86	21.30 [20.92, 21.68]
Guo, non-impacted	2014	China	304	22.76 [22.50, 23.01]
Guo, impacted	2014	China	181	23.01 [22.70, 23.32]
Guo	2015	China	269	22.43 [22.19, 22.67]
Rouge-Maillart	2011	France	1	16.50 [16.50, 16.50]
Zandi	2015	Iran	287	21.55 [21.30, 21.80]
Johan	2012	Malaysia	252	22.37 [22.13, 22.61]
Elshehawi	2016	Malta	44	22.14 [21.76, 22.52]
Olze	2010	Native Canada	11	23.20 [21.55, 24.85]
Olze	2006	South Africa	272	22.90 [22.61, 23.19]
Olze	2012	South Africa	217	22.80 [22.53, 23.07]
Lee	2009	South Korea	187	21.10 [20.93, 21.27]
Prieto	2004	Spain	46	19.74 [19.43, 20.05]
Karadayi	2014	Turkey	49	21.09 [20.78, 21.40]
Boonpitaksathit	2011	UK	45	19.46 [19.01, 19.91]



Test for heterogenitet, $p < 0.0001$

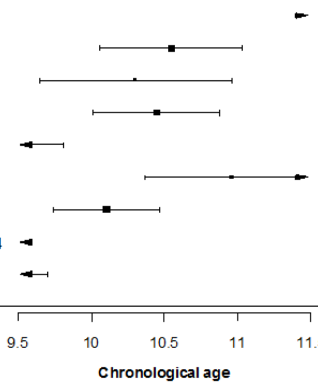
$I^2 = 98.49\%$

Figurer 10-12: Gjennomsnittlig kronologisk alder når visdomstann 38 er i utviklingsstadiene F, G og H for gutter.

CA: kronologisk alder; 95% CI: 95 % konfidensintervall

Figur 13 Jenter A

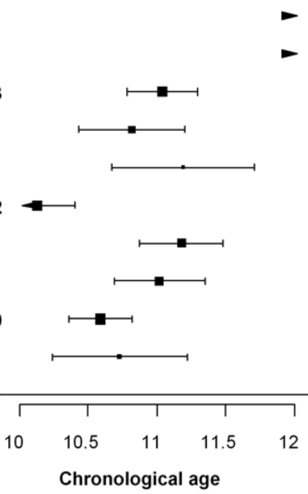
Authors	Year	Country	Size	CA [95% CI]
Meinl	2007	Austria	1	12.60 [12.60, 12.60]
Zeng	2010	China	51	10.55 [10.05, 11.05]
Li	2012	China	25	10.30 [9.63, 10.97]
Guo	2015	China	40	10.45 [10.01, 10.89]
Zandi	2015	Iran	68	9.47 [9.14, 9.80]
Elshehawi	2016	Malta	23	10.97 [10.37, 11.57]
Lee	2009	South Korea	73	10.10 [9.73, 10.47]
Karatas	2013	Turkey	124	9.30 [9.04, 9.56]
Karadayi	2014	Turkey	28	9.34 [8.99, 9.69]



Test for heterogenitet, p < 0.0001
I^2 = 89.31%

Figur 14 Jenter B

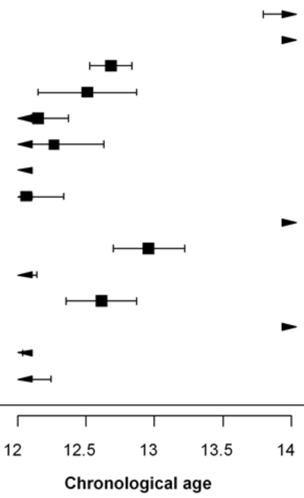
Authors	Year	Country	Size	CA [95% CI]
Meinl	2007	Austria	5	12.30 [12.04, 12.56]
Lopez	2013	Brazil	1	15.70 [15.70, 15.70]
Zeng	2010	China	113	11.02 [10.77, 11.27]
Li	2012	China	50	10.80 [10.41, 11.19]
Guo	2015	China	23	11.17 [10.65, 11.69]
Zandi	2015	Iran	102	10.11 [9.83, 10.39]
Elshehawi	2016	Malta	73	11.16 [10.86, 11.46]
Lee	2009	South Korea	50	11.00 [10.67, 11.33]
Karatas	2013	Turkey	130	10.57 [10.34, 10.80]
Karadayi	2014	Turkey	32	10.71 [10.22, 11.20]



Test for heterogenitet, p < 0.0001
I^2 = 93.34%

Figur 15 Jenter C

Authors	Year	Country	Size	CA [95% CI]
Meinl	2007	Austria	14	14.60 [13.76, 15.44]
Lopez	2013	Brazil	9	16.50 [15.23, 17.77]
Zeng	2010	China	385	12.67 [12.52, 12.82]
Li	2012	China	145	12.50 [12.14, 12.86]
Guo, non-impacted	2014	China	135	12.15 [11.92, 12.37]
Guo, impacted	2014	China	68	12.26 [11.90, 12.62]
Guo	2015	China	129	11.78 [11.59, 11.97]
Zandi	2015	Iran	82	12.06 [11.79, 12.33]
Johan	2012	Malaysia	20	14.55 [14.25, 14.85]
Elshehawi	2016	Malta	101	12.94 [12.68, 13.20]
Olze	2010	Native Canada	5	11.70 [11.26, 12.14]
Lee	2009	South Korea	137	12.60 [12.35, 12.85]
Prieto	2004	Spain	11	14.99 [14.20, 15.78]
Karatas	2013	Turkey	97	11.78 [11.53, 12.03]
Karadayi	2014	Turkey	35	11.78 [11.32, 12.24]

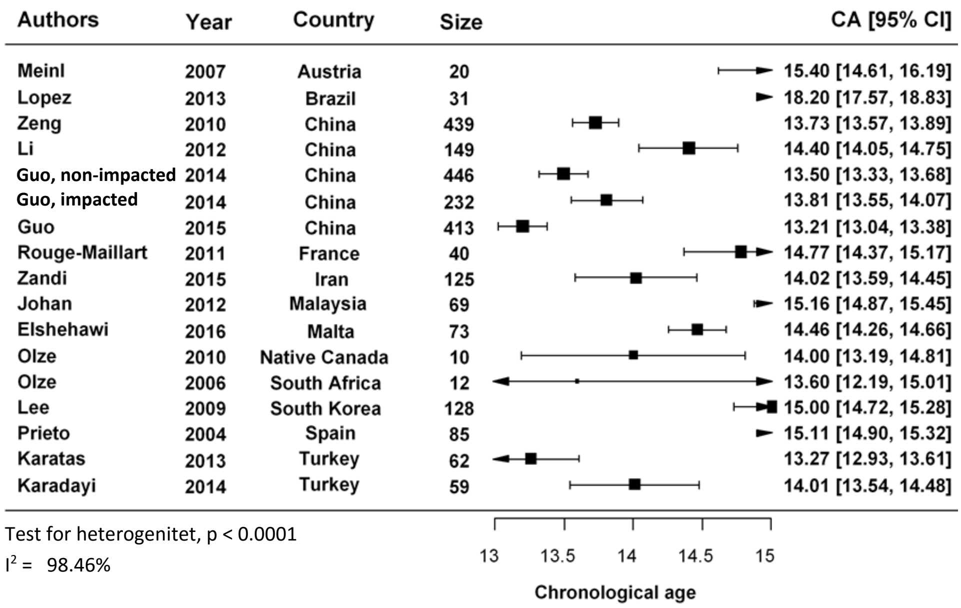


Test for heterogenitet, p < 0.0001
I^2 = 98.81%

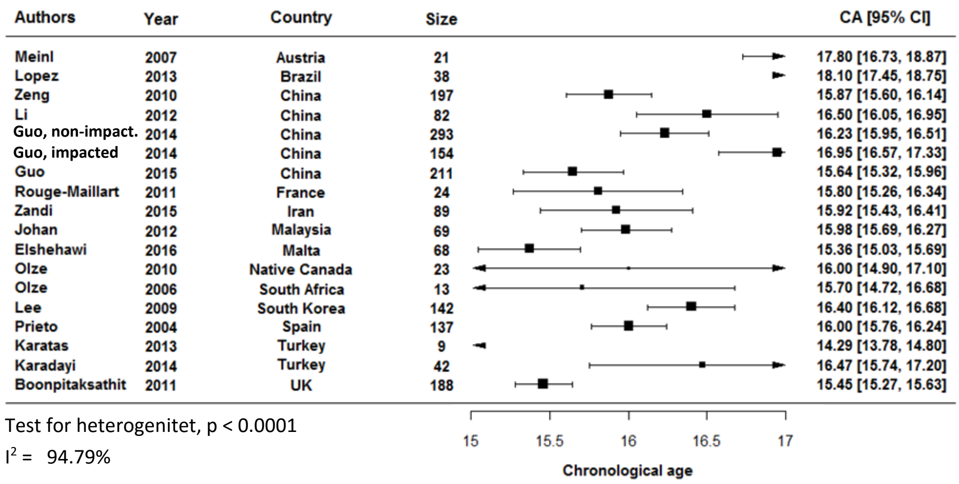
Figurer 13-15: Gjennomsnittlig kronologisk alder når visdomstann 38 er i utviklingsstadiene A, B og C for jenter.

CA: kronologisk alder; 95% CI: 95 % konfidensintervall

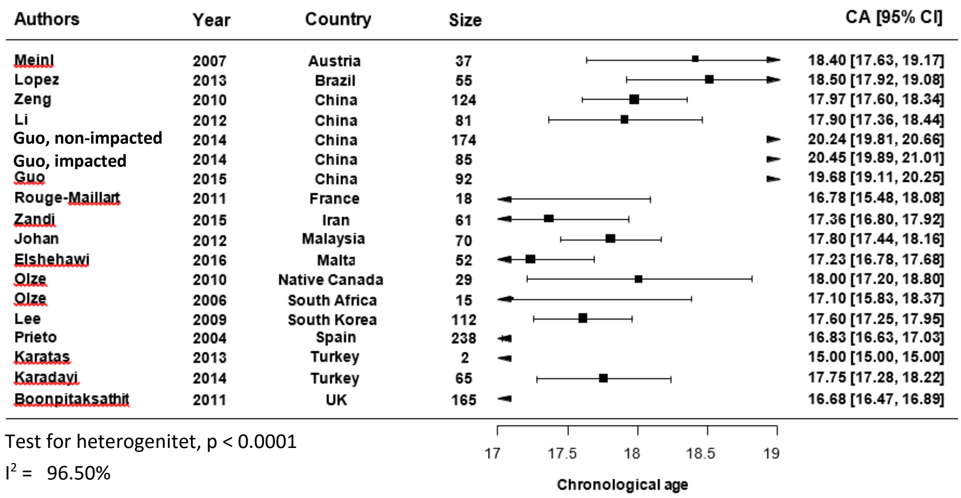
Figur 16 Jenter D



Figur 17 Jenter E



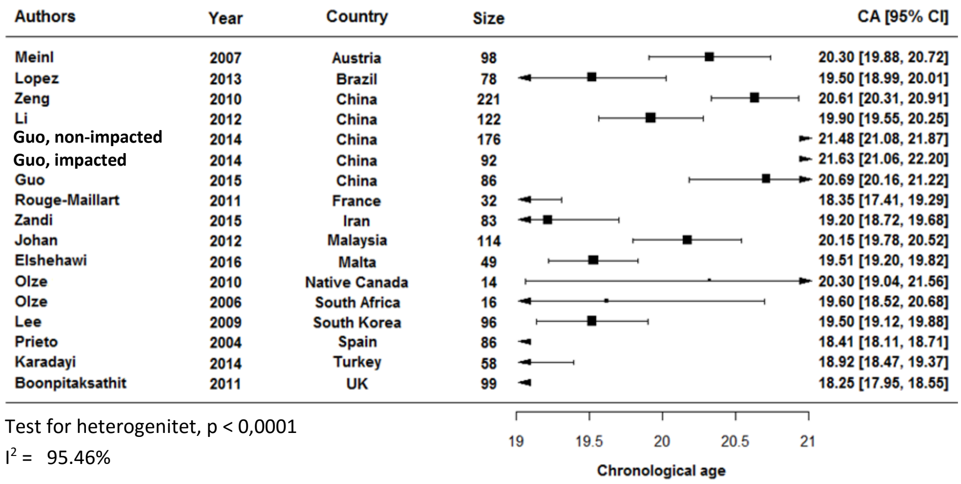
Figur 18 Jenter F



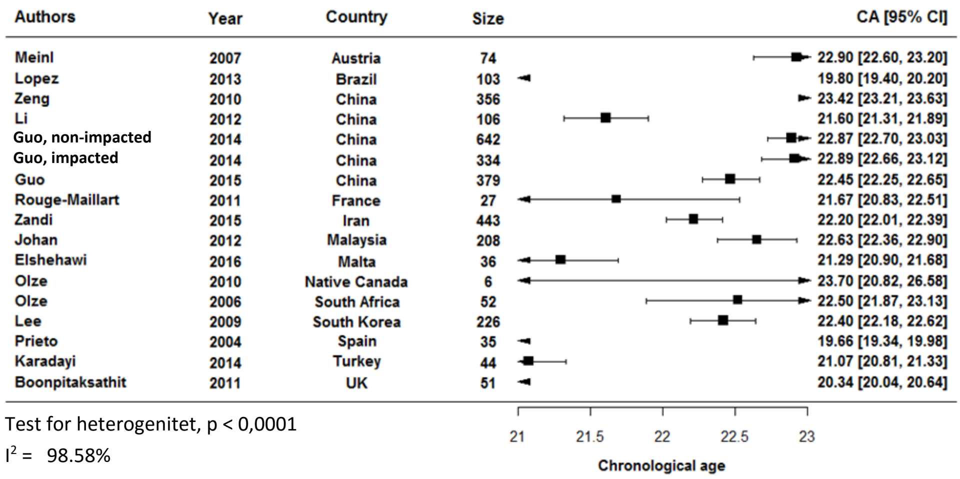
Figurer 16-18: Gjennomsnittlig kronologisk alder når visdomstann 38 er i utviklingsstadiene D, E og F for jenter.

CA: kronologisk alder; 95% CI: 95 % konfidensintervall

Figur 19 Jenter G



Figur 20 Jenter H



Figurer 19-20: Gjennomsnittlig kronologisk alder når visdomstann 38 er i utviklingsstadiene G og H for jenter.

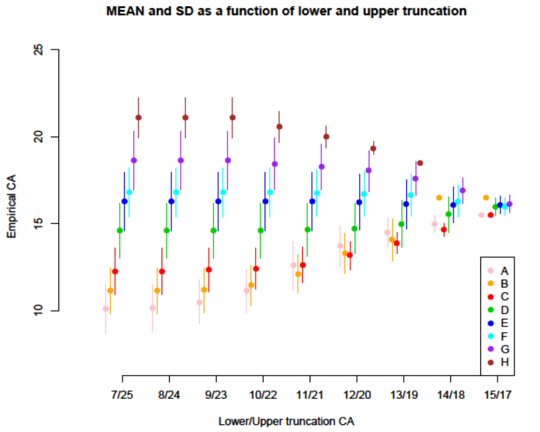
CA: kronologisk alder; 95% CI: 95 % konfidensintervall

Figurene 5 til 20 viser at det er svært stor heterogenitet for gjennomsnittlig kronologisk alder mellom de ulike studiene, for alle stadier og for begge kjønn. For eksempel viser figur 5 at laveste gjennomsnittsalder for gutter i utviklingsstadium A er 8,97 år i en studie fra Tyrkia og høyeste gjennomsnittsalder er 10,30 år i en studie fra Malta. Usikkerheten til estimatene for populasjonsgjennomsnittet, vist gjennom 95 % konfidensintervall er også stor for mange av studiene. Dette skyldes blant annet at mange av studiene har få observasjoner for hvert utviklingsstadium, helt ned i kun én person (f.eks. figur 14, Jenter stadium B (22). Appendix 6, figurene A1-A16, viser en forenklet grafisk fremstilling av resultater for alle fire visdomstennene i studiene som har oppgitt dette. Disse figurene viser at fordelingen av kronologisk alder for gitte utviklingsstadier har godt samsvar mellom de fire visdomstennene fra samme studie.

Selv om vi ikke gjennomførte metaanalyser for å beregne et samlet estimat for gjennomsnittlig kronologisk alder i utviklingsstadiene, er det oppgitt p-verdi for statistisk test for heterogenitet og I^2 -verdi for alle figurene. Resultatene fra den statistiske vurderingen av heterogenitet viser at det er større variasjon mellom disse studiene enn det man kan forvente på grunn av tilfeldigheter. Andelen av variansen i metaanalysene som kan tilskrives heterogenitet angis ved I^2- verdien og er i mange tilfeller > 80 %. Vi drøfter mulige kilder til denne heterogeniteten i diskusjonskapittelet. Vi vurderer imidlertid at en vesentlig andel av den observerte heterogeniteten er knyttet til fenomenet aldersmimikering.

For å illustrere effekten av aldersmimikering kan vi ta utgangspunkt i reelle tall fra studien til Lee 2009 (14) (deres tabell 4, side 108) der vi betrakter data for visdomstann 38 for gutter. Tabellen i studien er den samme som tabellen til venstre i figur 21. Antall individer innenfor hver gruppering av kronologisk alder er angitt for hvert utviklingsstadium A til H.

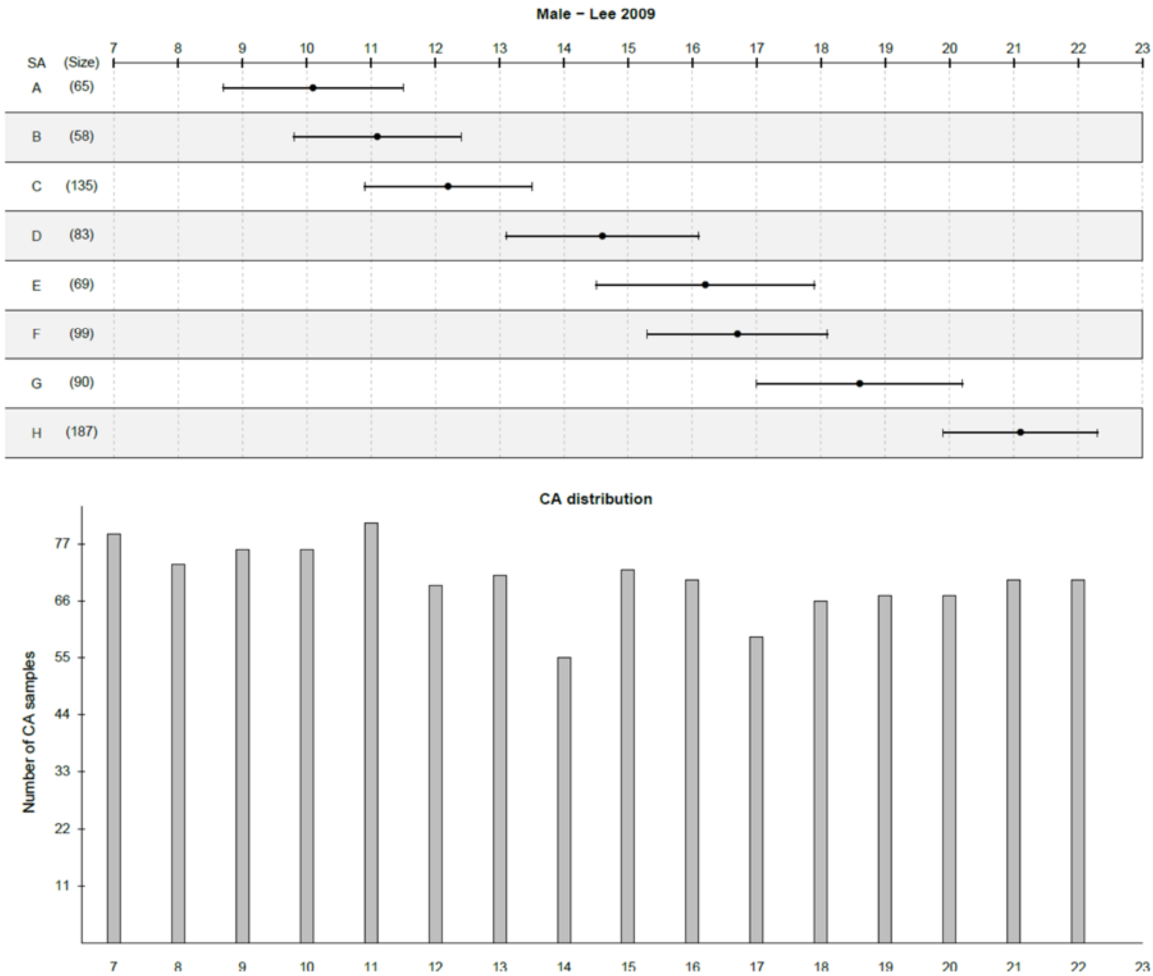
CA	A	B	C	D	E	F	G	H	Total
7.5	1								1
8.5	11	1	2						14
9.5	21	8	4						33
10.5	22	20	13	1					56
11.5	5	19	37	2					63
12.5	2	5	41	8	1				57
13.5	1	4	25	21	5	1			57
14.5	1		11	20	10	5			47
15.5	1		2	13	13	27	5		61
16.5		1		12	18	24	9		64
17.5				5	11	22	18		56
18.5				1	7	15	25	6	54
19.5					3	3	17	32	55
20.5					1	1	7	47	56
21.5						1	5	51	57
22.5							4	51	55
23.5									0
24.5									0



Figur 21: Tabellen til venstre viser en reell fordeling av individer med ulike kronologiske aldre (CA) som er vurdert til å være i utviklingsstadium A til H. Figuren til høyre viser hvordan gjennomsnittsalderen og standardavviket (angitt som vertikal linje +/- 1 SD fra gjennomsnittet) for hvert utviklingsstadium (fargekodet) endrer seg når man inkluderer deltakere fra et mindre aldersspenn. Figuren starter med alle deltakere fra 7-25 år (den originale studien) og viser trinnvis mindre aldersspenn helt ned til gruppen 15-17 år.

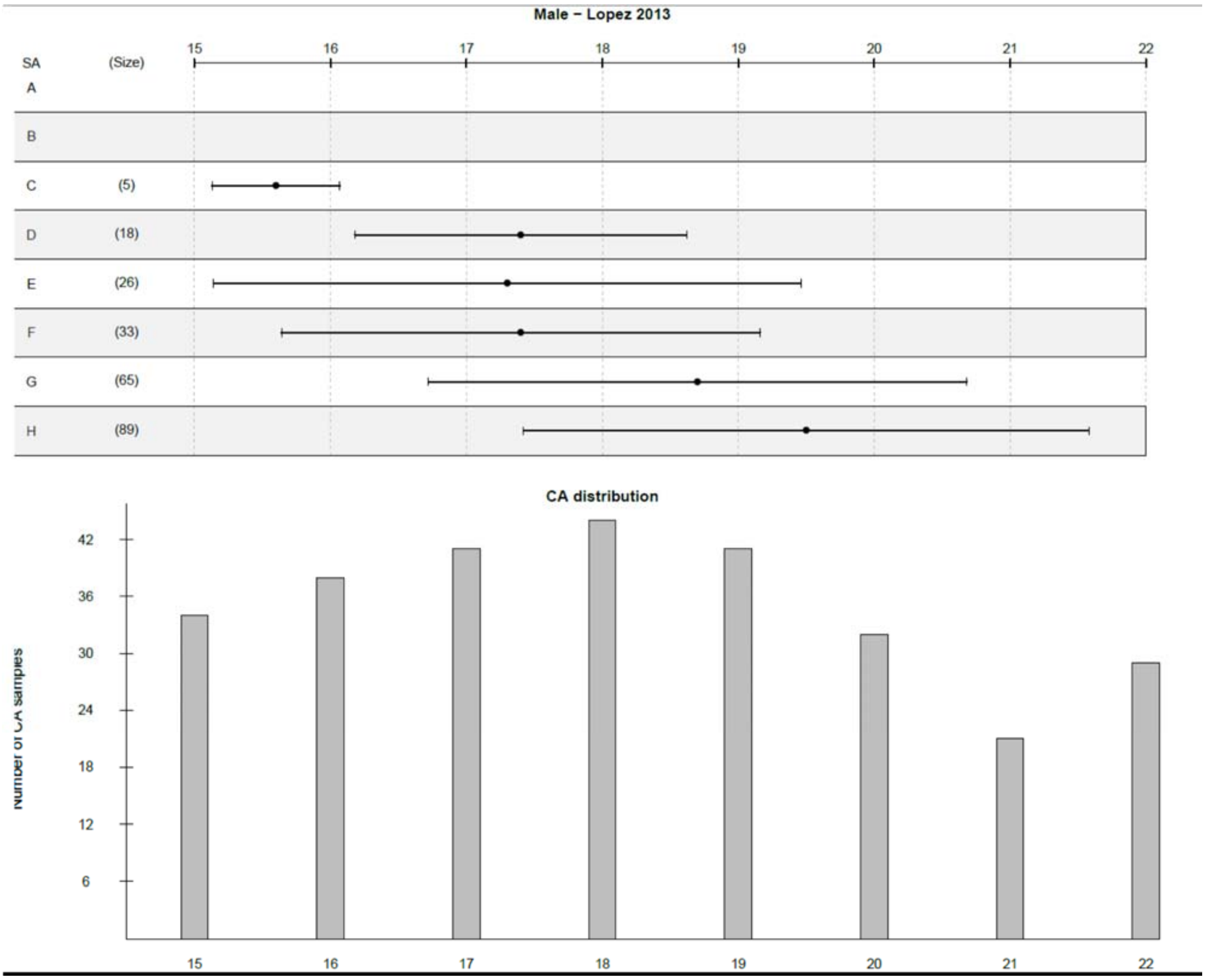
Figur 21 illustrerer effekten av aldersmimikering ved at gjennomsnittsverdiene for kronologisk alder for de ulike stadiene dras mot alderen til de inkluderte individene i studien. Dette skjer ved at aldersspennet snevres inn slik at aldersfordelingene på de ulike stadiene følger alderen til individene man inkluderer i studien. Aldersspennet av deltakerne i studiene påvirker derved den observerte gjennomsnittsalderen i hvert utviklingsstadium. I tillegg illustrerer figuren at et smalere aldersspenn reduserer den observerte variasjonen (standardavviket) for utviklingsstadiene. Altså blir spredningsmålet kraftig underestimert slik at metoden kan fremstå som bedre enn den egentlig er. Oppsummert kan aldersmimikering både føre til vesentlig forskyving av de observerte gjennomsnittsaldrene i hvert utviklingsstadium og endre estimatet av variasjonen.

I kvalitetsvurdering av inkluderte studier fant vi kun noen studier som hadde valgt ut et relativt likt antall deltakere fra hvert årskull og hvor aldersspennet var relevant for de analyserte utviklingsstadiene. Av disse trekker vi ut studien til Lee og medarbeider (20) som et eksempel. Funnene og aldersfordeling for gutter fra denne studien fremstilles i figur 22. Kronologisk alderssammensetning var relativt jevn med fra 55 til 81 deltakere i hvert årskull. I tillegg strakk aldersspennet på de inkluderte deltakerne seg langt ut i begge retninger slik at forventet gjennomsnittsalder for utviklingsstadier fra B til G dekkes godt. En mulig svakhet ved studiedesignet er at den øvre aldersgrensen muligens burde vært høyere for å få dekket hele fordelingen til utviklingsstadium G.



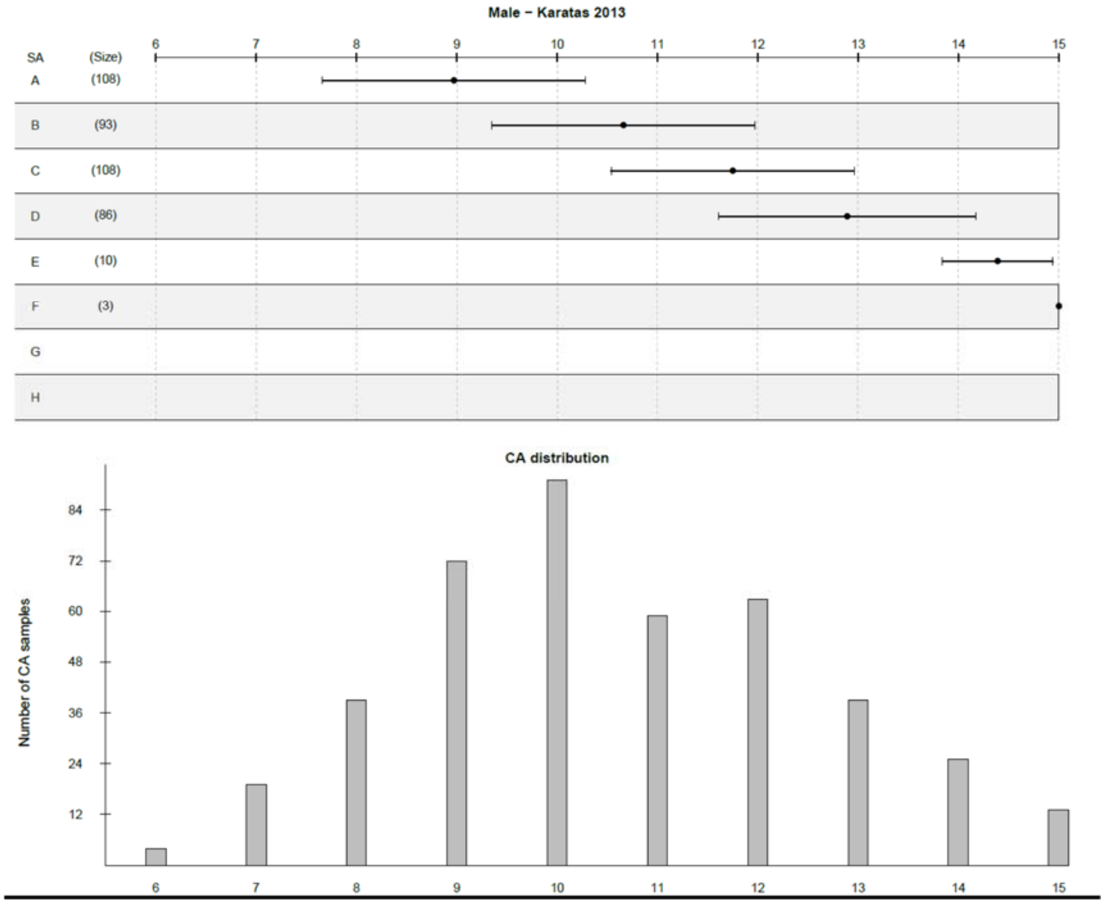
Figur 22: Det øvre plottet viser gjennomsnittene (punktene) og variasjon i kronologisk alder (CA) for ulike utviklingsstadier (A-H). Linjen angir ett standardavvik (SD) på hver side. Det nedre plottet viser antall individer for hver aldersgruppe som er inkludert i studien (i heltall). Observasjonene er hentet fra Lee 2009 (20).

Som en motsetning til denne studien har vi trukket frem studiene til Lopez 2013 (22) og Karatas 2013 (19). Figur 23 illustrerer at studien fra Lopez og medarbeidere, ikke gir noen god beskrivelse av hvordan kronologisk alder fordeler seg i utviklingsstadium D, siden alderen på de inkluderte deltakerne starter på 15 år.



Figur 23: Det øvre plottet viser gjennomsnittene (punktene) og variasjon i kronologisk alder (CA) for ulike utviklingsstadier (A-H). Linjen angir ett standardavvik (SD) på hver side. Det nedre plottet viser antall individer for hver aldersgruppe som er inkludert i studien (i heltall). Observasjonene er hentet fra Lopez 2013 (22).

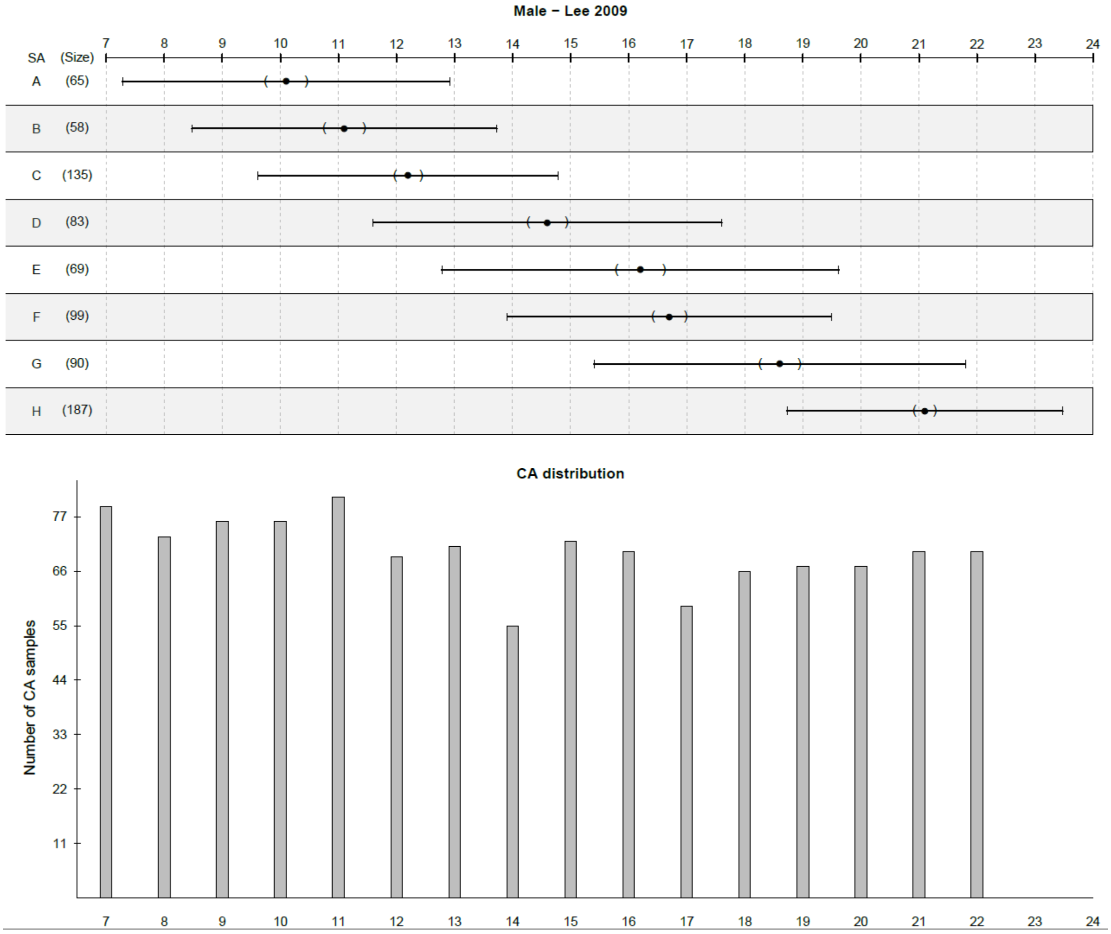
Figur 24 illustrerer hvordan problemet kan være i den andre enden av skalaen. Siden høyeste kronologisk alder for studiedeltakerne i Karatas og medarbeidere er 15 år, vil ikke aldersfordelingen kunne inkludere personer med høyere alder. I tillegg er det inkludert flere deltakere som er 10 år enn i de andre alderskategoriene. Dette fører til at gjennomsnittsalder for flere av utviklingsstadiene blir forskjøvet i retning mot 10 år.



Figur 24: Det øvre plottet viser gjennomsnittene (punktene) og variasjon i kronologisk alder (CA) for ulike utviklingsstadier (A-H). Linjen angir ett standardavvik (SD) på hver side. Det nedre plottet viser antall individer for hver aldersgruppe som er inkludert i studien (i heltall). Observasjonene er hentet fra Karatas 2013 (19).

For praktisk bruk av tannrøntgen som en aldersestimeringsmetode er det ikke tilstrekkelig å oppgi kun gjennomsnittlig kronologisk alder med standardavvik for de ulike tannstadiene for tredje molar. Man må også oppgi et prediksjonsintervall for hver av utviklingsstadiene som tar hensyn til at det er usikkerhet knyttet til flere faktorer. Vi har fulgt formelen som står beskrevet i Chaumoitre fra 2016 (33) som er en av de inkluderte studiene i vår parallelle systematiske oversikt om samsvaret mellom kronologisk alder og skjelettalder basert på håndrøntgen vurdert mot Greulich & Pyle atlaset (1). De beregner et 95 % prediksjonsintervall som viser et intervall der 95 % av de alderstestede individene (fra en tilhørende populasjon) vil ha sin ukjente kronologiske alder. Et slikt prediksjonsintervall er basert på gjennomsnittet, standardavviket og antall observasjoner for et gitt stadium. Intervallet kan man benytte for å anslå en sikkerhetsmargin av kronologisk alder for ulike observerte tannstudier, basert på ett angitt stadium gradering av tredje molar.

Som eksempel viser vi hvordan 95 % prediksjonsintervall vil være hvis man legger studien til Lee og medarbeidere 2009 til grunn. Vi har valgt denne studien fordi de har inkludert deltakere på en slik måte at man i stor grad unngår aldersmimikering. Figur 25 viser gjennomsnittlig kronologisk alder med 95 % prediksjonsintervall på de ulike tannstadiene for tredje molar fra denne studien. Bredden på 95 % prediksjonsintervallene varierer fra 4,7 år for H stadiet til 6,8 år for stadium E. Denne figuren illustrerer hvordan man kan bruke slike studier til å estimere alder ved hjelp av stadium gradering av tredje molar og tallfeste antatt usikkerhet i estimatet.



Figur 25: Det øvre plottet viser gjennomsnitt (punktet) og variasjon av kronologisk alder (CA) for ulike stadier (A-H). Parentesene gir et 95 % konfidensintervall av populasjonsgjennomsnittet, mens linjen gir et 95 % prediksjonsintervall (ser er omtrent -/+ 2 standardavvik til hver side) av CA. Det nedre plottet viser antall individer for hver aldersgruppe som er inkludert i studien (i heltall). Omregningene er basert på resultatene til Lee 2009 (20).

Diskusjon

Hovedfunn

I denne systematiske oversikten har vi oppsummert studier som undersøker sammenhengen mellom kronologisk alder og utviklingsstadier av visdomstenner ved hjelp av Demirjians gradering for molarer. Vi inkluderte 18 studier som oppfylte inklusjonskriteriene og observerte hvordan kronologisk alder fordelte seg ut fra de ulike utviklingsstadiene for tredje molar.

Et hovedfunn i rapporten er at flertallet av disse studiene hadde resultater som er påvirket av fenomenet aldersmimikering. Ved aldersmimikering blir beregnet gjennomsnittsalder for hvert utviklingsstadium sterkt påvirket av at det er ulikt antall deltakere i hvert alderskull og av det totale aldersspennet i studien. Våre resultater indikerer at dette er hovedårsaken til de store ulikhetene i aldersinndelingen av tannstadiene mellom de ulike studiene. Vi vurderte derfor at det ikke var hensiktsmessig å gjennomføre metaanalyser for å få et samlet estimat av den gjennomsnittlige kronologiske alder for de ulike tannstadiene. Kun noen få av studiene hadde et studiedesign og var gjennomført slik at de gir grunnlag for en rettferdig fremstilling av metodens evne til å predikere alder. Studiene gir ikke grunnlag for å konkludere om det finnes forskjeller i utviklingen av visdomstennene mellom ulike populasjoner og regioner.

Kvaliteten på forskningsresultatene

Alderssammensetningen av deltakerne i de undersøkte studiene av Demirjians stadier på visdomstenner virker tilfeldig og lite systematisk gjennomført. Dette kan skyldes at studiene er tverrsnittsstudier hvor man har benyttet tannrøntgenbilder som er tatt for et annet formål enn aldersbestemmelse. Dette har ført til at antall deltakere i hver aldersgruppe har blitt svært ulikt. Men det kan også virke som om noen forfattere har valgt ut personer i fra den aldersgruppen de har ment var mest interessant. Dette fører igjen til at stadiene som beskrives får et estimat på gjennomsnittsalder i stadiene som er for nær hverandre på grunn av et snevert aldersutvalg i gruppen som er undersøkt. Som et minimum må man inkludere individer som «dekker over» antatt normalvariasjon i alder for det stadiet man er interessert i og samtidig har en jevn alderssammensetning i utvalget. Dette er en forutsetning for en rettferdig beskrivelse av hvordan kronologisk alder fordeler seg på dette stadiet.

Skjevhetene i forskningsresultater som oppstår på grunn av aldersmimikering ble først beskrevet for aldersbestemmelser av arkeologiske skjeletter. Bocquet-Appel og Masset påpekte allerede i 1982 at metoder for aldersbestemmelse ofte blir forskjøvet på grunn av aldersfordelingen i referansegruppen med kjent alder (9). Vi vurderer at aldersmimikering utgjør en vesentlig kilde til den store variasjonen i gjennomsnittlig kronologisk alder knyttet til de ulike tannstadiene. For eksempel har Lopez og medarbeidere (22) kun inkludert gutter fra 15-22 år. Dette fører til at A-stadiet blir forskjøvet oppover i alder, mens stadium H blir lavere enn i de fleste andre studier som inkluderer personer opp til 26-27 år. Denne studien viser klart hvordan alderssammensetningen i en studie påvirker hvor gjennomsnittsalderen i stadiene plasserer seg (se fig. 23). Vi mener også at ulike antall individer i hver aldersgruppe kan påvirke observert gjennomsnittsalder for stadiene i flere av disse studiene. Tre studier har likt eller relativt likt antall deltakere i hver aldersgruppe, men de har forskjellig øvre og nedre aldersgrense. For eksempel har en av disse studiene, av Lee og medarbeidere (20), et relativt likt antall (55 til 81 individer) i hver aldersgruppe fra 4-26 år og de poengterer at de har valgt 5-10 tilfeldige tannrøntgenbilder for hvert alderstrinn med 0,1 år intervaller for å oppnå en helt jevn aldersfordeling. Her kan man anta at stadiene i liten grad er forskjøvet på grunn av alderssammensetningen, og derved gir denne studien et riktigere resultat.

Endestadiet H er en spesiell utfordring fordi tenner forblir i dette stadiet livet ut. Lee og medarbeidere har prøvd å finne en løsning på dette problemet ved at de analyser kun på aldersgruppen som har minst én visdomstann som ikke er fullt utviklet. For gutter utgjør denne gruppen individer fra 7 år til 22,9 år. H stadiet basert på dette utvalget får derved en lavere gjennomsnittsalder enn når det beregnes på hele utvalget, siden menn over 22,9 år ekskluderes (273 testpersoner ekskluderes fra studien). Flere har foreslått løsninger på problemet til stadium H. Roberts og medarbeidere (34) gjorde en sensurering av H ved å kun inkludere personer med maksimal alder for stadium G. I denne studien fant de at denne grensen gikk ved 21,64 år. Olze og medarbeidere (25) nevnte i sin diskusjon at gjennomsnittsalderen for H stadiet vil påvirkes av den øvre aldersgrensen for individer man inkluderer i studien. De foreslo derfor at man angir alderen som gir en 50 % sannsynlighet for å være i stadium H, som en «robust» verdi for representasjon av alder for dette stadiet.

Etter vår mening er aldersmimikering den viktigste kilden til resultatskjevheten i kunnskapsfeltet, noe som gjør det umulig å sammenfatte enkeltstudier som ikke har tatt hensyn til dette fenomenet. Dette er et viktig poeng som må ut til alle i fagfeltet. Hovedfunnet i denne rapporten er at alderssammensetningen i en studie for å beskrive fordelingen av kronologisk alder for gitte utviklingsstadier, er avgjørende for at fremstillingen blir riktig. Andre viktige kilder til heterogenitet mellom studiene er målefeil i analysene som er utført, blant annet den subjektive tolkningen av røntgenbildene opp mot Demirjians utviklingsstadier. Selv om mange har studiene har utført undersøkelser av hvordan tolkningen av bildene samsvarer mellom ulike personer i studien, har ingen oppgitt om tolkning av bildene samsvarer med andre studiesteder. Variasjonen man ser mellom studier av utvikling av tredje molar som benytter Demirjians stadier har i mange tilfeller blitt tolket som forskjeller mellom populasjoner og etnisiteter i tannutvikling. Vi mener at aldersmimikering er en så vesentlig kilde til variasjon at datagrunnlaget er for svakt til å kunne konkludere med om slike forskjeller finnes.

Noen studier har sammenlignet etniske grupper som for eksempel Olze og medarbeidere 2004 (35). I denne studien var aldersspennet for de ulike etniske gruppene omtrent lik, men antallet individer per aldersgruppe varierte i stor grad og det vil derved også påvirke fordelingen av kronologisk alder for hvert utviklingsstadium. Derfor blir sammenligningen også her påvirket av aldersmimikering. Rougé-Maillart og medarbeidere (28) påpekte at deres sør-franske populasjon ligner på Prietos (27) spanske populasjon når det gjaldt alder og utviklingsstadier for tredje molar og forklarte dette med lik etnisitet. Vi mener at grunnen til at disse to studiene sammenfaller like godt kan skyldes like aldersspenn blant de undersøkte deltakerne.

Det er viktig å ta hensyn til skjevheten som kan oppstå gjennom aldersmimikering i fremtidige studier med formål om å validere bruken av tannutviklingsstadier for aldersestimering. Godt designede og gjennomførte studier er en forutsetning for å vurdere om det er eventuelle forskjeller i tannutvikling mellom populasjoner. Fra et medisinsk perspektiv er det spesielt relevant at ulike populasjoner og etniske grupper kan ha genetisk likhet gjennom slektskap, liknende sosioøkonomisk status og levekår, og liknende levevaner (36). Det er kjent at slike faktorer hver for seg kan påvirke både vekstmønster og sykdomsrisiko, men det kan være vanskelig å skille den relative betydningen av disse faktorene fra hverandre. Mens genetisk likhet gjennom slektskap vil være relativt stabil, vil sosioøkonomisk status, levekår og levevaner kunne endres over tid i et land og ved for eksempel migrasjon.

Hvordan unngå effekten av aldersmimikering i praksis.

Vi har funnet at en jevn alderssammensetning på personer inkludert i en studie er viktig for at fordelingen (gjennomsnitt og standardavvik) av kronologisk alder for et tannstadium blir beskrevet riktigst mulig. I praksis kan en begrensning være at man har tilgjengelige tannrøntgenbilder av færre individer for noen aldersgrupper enn for andre.

Av de inkluderte studiene i vår oppsummering fant vi noen studier (17, 20, 21) som i relativt stor grad klarer å unngå aldersmimikering. Ideelt sett skulle vi hatt flere slike studier av denne typen fra ulike deler av verden for å få et mer komplett bilde av denne metodens pålitelig for aldersestimering.

En fordel ved å oppgi data som fordelingen av kronologisk alder gitt for ulike utviklingsstadier, er at du kan hente ut denne fordelingen direkte. Men denne fremstillingen vil som nevnt være utsatt for aldersmimikering. En alternativ fremgangsmåte til å ha jevnstore grupper i alle aldre som likevel omgår problemet med aldersmimikering er å bruke statistiske metoder. Ved slike metoder vil man først beskrive hvordan tannstadiene endrer seg når kronologisk alder øker. Deretter ser man på hvilke kronologiske aldre som er mest sannsynlige til å beskrive et gitt tannstadium. Dette er den foreslåtte statistiske fremgangsmåten i Boldsen 2002 (37), Konigsberg 2008 (38), og Thevissen 2013 (39). Denne fremgangsmåten var opprinnelig utviklet for aldersestimering av arkeologiske skjeletter, men er også benyttet for aldersbestemmelse ved hjelp av tredje molar. Heller ikke disse metodene vil direkte omgå problemet med å beskrive fordelingen til endestadium H.

Alderstesting for om en person er over eller under 18 år.

I praksis er det ofte aktuelt å utføre aldersestimering for å vurdere om en person er over eller under en gitt aldersgrense. Siden vårt utgangspunkt for denne systematiske oversikten var å oppsummere sammenhengen mellom kronologisk alder og Demirjians utviklingsstadier av visdomstenner inkluderte vi ikke dette som endepunkt i vår analyse. Det meste som finnes i litteraturen (se tabell 3 i Roberts og medarbeidere (34)), tar for seg studier som angir en opptelling av hvor mange av individene som er over 18 år for gitte stadier. Tanken er at man skal kunne bruke denne informasjonen til å angi sannsynligheten for at et individ med et gitt utviklingsstadium er over 18 år. Som tidligere påpekt vil også disse angitte sannsynlighetene være avhengig av alderssammensetningen i studien. Stadium H vil særlig være et problem siden sannsynligheten vil være direkte relatert til hvor høy alder man har inkludert i studien.

I tillegg til å se på sannsynligheten for å være over 18 år for ulike stadier, konstruerer Liversidge og Marsden (40) ulike tester for å avgjøre om en ny person er over eller under 18 år. De laget for eksempel en test som sier at dersom du er i siste stadium så er du over 18 år. Studien evaluerte en slik test ved å telle andel individer i referansesettet som var i det siste stadium gitt at de var over 18 år (sensitivitet - sann positiv), og andel individer i referansesettet som var i siste stadium gitt at de var under 18 år (falsk positiv). Ulempen ved en slik tilnærming er at kriteriene i testen er allerede satt for om man avgjør om personen er over/under 18 år, med tilhørende feilrate (sann og falsk positiv) som er forankret i referansesettet. Effekten av aldersmimikering vil derfor også gjøre seg gjeldende i dette tilfellet hvis man ikke tar hensyn til dette ved design av studien.

De inkluderte studiene kan også ha andre skjevheter som gjelder observatørforskjeller og mangel av blinding, i tillegg til inklusjons- og eksklusjonskriterier. Vi har gjennomgått alle inkluderte studier etter QUADAS-kriteriene og denne vurderingen kommer frem av tabell 2 i resultater.

Styrker og svakheter

Styrken ved denne systematiske oversikten er den systematiske og transparente tilnærmingen vi har benyttet for å svare på spørsmålet. Vi har gjennomført systematiske litteratursøk i mange elektroniske databaser, og vi har benyttet klare inklusjons- og eksklusjonskriterier. To personer har uavhengig av hverandre vurdert hver referanse etter disse kriteriene, samt uavhengig av hverandre vurdert kvaliteten på de inkluderte studiene. Bruk av uavhengige vurderinger er med på å redusere risiko for feil. Systematikk og transparens er med andre ord de viktigste styrkene ved en systematisk oversikt. Det skal være mulig å etterprøve alle ledd i arbeidet som er utført og vurderingene som er lagt til grunn for våre konklusjoner.

Selv om vi har utført et grundig litteratursøk med høy grad av sensitivitet, er det alltid mulig at det finnes studier som vi ikke har identifisert. En innebygd svakhet med systematiske oversikter er at de kan bli utdatert når det publiseres flere nye studier, noe som skjer kontinuerlig. Datagrunnlaget i denne systematiske oversikten er antatt å være oppdatert fram til mai 2016.

Overensstemmelse med andre oversikter

En tidligere metodevurdering fra Kunnskapssenteret (nå Kunnskapssenteret i Folkehelseinstituttet), Graff med flere 2006 (10) tok for seg tann- og håndrøntgen for aldersvurdering av personer mellom 16 og 20 år. Denne rapporten oppsummerte aldersestimering basert på utvikling av visdomstenner ved hjelp av flere metoder. Også de fant at det var stor heterogenitet mellom studiene. Forfatterne mente at den viktigste grunnen til dette var at forfatterne hadde brukt ulike graderingssystemer. Det ble påpekt at forskjellene mellom etnisiteter ved ulike tannstadier virker stor, spesielt for endestadium H, og at standardavviket ved estimering av alder for ulike etnisiteter varierer mye. Forfatterne mente dette også kunne skyldes forskjeller mellom studiene når det gjaldt valg av aldersintervall for populasjonene og eksemplifiserer dette ved hjelp av stadium H. Rapporten vurderte ikke problemet som kan oppstå ved aldersmimikering. Vi har imidlertid kun én felles inkludert studie siden 17 av våre inkluderte studier er publisert etter deres oppsummering.

Enkeltstudier har vært brukt for å estimere alder ved hjelp av Demirjians utviklingsstadier for visdomstenner. Mincer og medarbeidere (5), var de første som laget en tabell over sammenhengen med alder og Demirjians stadier for tredje molar. Denne studien bestod av 823 personer, beskrevet som 80 % «whites» og 19 % «blacks» (forfatternes egne betegnelser) i en alder fra 14,1 til 24,9 år. Studien har ikke oppgitt antall individer som ble kategorisert inn under de ulike stadiene. Vi har derfor ekskludert denne fra vår analyse siden den ikke oppfylte inklusjonskriteriene for dataformat. Dette problemet gjelder for en rekke av studiene som vi har ekskludert. Siden studien til Mincer og medarbeidere kun inkluderer personer fra 14 år gjorde de ingen kartlegging av stadiene A, B og C (fordi et nedre aldersspenn på 14 år ikke vil dekke stadiene opp til C). Imidlertid har man ofte andre tenner under utvikling som kan graderes, som andre molar, når tredje molar er i disse stadiene.

Konklusjon

I denne systematiske oversikten har vi oppsummert vitenskapelig litteratur som undersøker samsvaret mellom Demirjians utviklingsstadier for visdomstenner og kronologisk alder.

Vi fant at estimert gjennomsnittsalder og aldersfordelingen i de ulike tannutviklingsstadiene i de fleste av studiene er uriktig beskrevet på grunn av alderssammensetningen av de inkluderte individene. For å få en riktig aldersfordeling må antallet inkluderte personer i studien være jevnt fordelt på alder. I tillegg må aldersspennet være såpass bredt at det omfatter alle aldre som kan falle inn i stadiet man er interessert i å beskrive. Dersom grunndata fra flere studier hadde vært tilgjengelig, kunne vi ha anvendt statistiske metoder som vil kunne gi en god beskrivelse av aldersfordelingen i de ulike utviklingsstadiene.

Kun noen av de inkluderte studiene har utført studien på en slik måte at de minimerer effekten av aldersmimikering. Et eksempel på en slik studie er Lee og medarbeidere fra 2009 utført i Sør-Korea. Med grunnlag i dette eksempelet, har vi regnet ut at 95 % prediksjonsintervall for kronologisk alder varierer fra 4,7 år til 6,8 år for de ulike utviklingsstadiene. Dette indikerer hvor stor usikkerheten rundt et aldersestimat kan være hvis Demirjians utviklingsstadier på tredje molar tas i bruk på en gitt populasjon som eneste metode for å estimere alder.

Vi trenger flere studier hvor resultatene er basert på en god beskrivelse av aldersfordelingen for på en mer sikker måte å kunne predikere kronologisk alder basert på utviklingsstadier for visdomstenner, samt for å vurdere usikkerheten i estimatene for aldersvurderingen. Slike studier må inkludere forskjellige populasjoner for at vi skal kunne si noe om hvorvidt regionale forskjeller påvirker sammenhengen mellom Demirjians utviklingsstadier og kronologisk alder.

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Vedlegg (appendixes)

Appendix 1: Literature search

Database: Ovid MEDLINE(R) In-Process & Other Non-Indexed Citations, Ovid MEDLINE(R) Daily and Ovid MEDLINE(R) 1946 to Present
Search date: 2016-05-19

1 Age Determination by Teeth/ (1422)
2 Age Determination by Skeleton/ (3937)
3 (age adj3 (determinat* or estimat* or assess*)).ti. (2851)
4 ((forensic or radiological) adj age).ti,ab. (158)
5 ((age or maturation or mature or ossification) adj5 (determinat* or estimat* or assess* or examinat*)).ti,ab. (41703)
6 (hand$1 or wrist$ or carpal or metacarpal or metacarpus or dental or teeth or tooth or third molar* or clavicle* clavicula* or collar bone* or femur or tibia* or fibula* or knee or knees or foot or feet or ankle or ankles).ti,ab. (904235)
7 (MRI or MR imag* or magnetic resonance imag* or ct scan* or cat scan* or (comput* adj2 tomograp*) or roentgen or x-ray* or xray* or radiolog* or radiograp*).ti,ab. (1032026)
8 5 and 6 and 7 (1297)
9 1 or 2 or 3 or 4 or 8 (7491)
10 exp Animals/ (20185560)
11 Humans/ (15941900)
12 10 not (10 and 11) (4243660)
13 9 not 12 (7007)
14 (greulich adj2 pyle).ti,ab. (238)
15 (tanner adj2 whitehouse).ti,ab. (246)
16 demirjian.ti,ab. (218)
17 haavikko.ti,ab. (20)
18 kullman.ti,ab. (6)
19 nortje.ti,ab. (5)
20 liversidge.ti,ab. (10)
21 kvaal.ti,ab. (13)
22 or/14-21 (674)
23 13 or 22 (7178)

Database: Embase 1974 to 2016 May 18
Search date: 2016-05-19

1 age determination/ (5176)
2 (age adj3 (determinat* or estimat* or assess*)).ti. (3291)
3 ((forensic or radiological) adj age).ti,ab. (199)
4 ((age or maturation or mature or ossification) adj5 (determinat* or estimat* or assess* or examinat*)).ti,ab. (57474)

5 (hand$1 or wrist$ or carpal or metacarpal or metacarpus or dental or teeth or tooth or third molar* or clavicle* clavicula* or collar bone* or femur or tibia* or fibula* or knee or knees or foot or feet or ankle or ankles).ti,ab. (1087091)
6 (MRI or MR imag* or magnetic resonance imag* or ct scan* or cat scan* or (comput* adj2 tomograp*) or roentgen or x-ray* or xray* or radiolog* or radiograp*).ti,ab. (1334461)
7 4 and 5 and 6 (1656)
8 1 or 2 or 3 or 7 (8121)
9 exp animals/ or exp invertebrate/ or animal experiment/ or animal model/ or animal tissue/ or animal cell/ or nonhuman/ (23089391)
10 human/ or normal human/ or human cell/ (17222575)
11 9 not (9 and 10) (5913580)
12 8 not 11 (7315)
13 (greulich adj2 pyle).ti,ab. (338)
14 (tanner adj2 whitehouse).ti,ab. (279)
15 demirjian.ti,ab. (208)
16 haavikko.ti,ab. (19)
17 kullman.ti,ab. (7)
18 nortje.ti,ab. (4)
19 liversidge.ti,ab. (18)
20 kvaal.ti,ab. (11)
21 or/13-20 (794)
22 12 or 21 (7692)

Database: Central
Search date: 2016-05-19
#1 MeSH descriptor: [Age Determination by Skeleton] explode all trees (99)
#2 MeSH descriptor: [Age Determination by Teeth] explode all trees (5)
#3 (age near/3 (determinat* or estimat* or assess*)):ti (30)
#4 ((forensic or radiological) next age) (0)
#5 ((age or maturation or mature or ossification) near/5 (determinat* or estimat* or assess* or examinat*)) (3474)
#6 (hand or hands or wrist or wrists or carpal or metacarpal or metacarpus or dental or teeth or tooth or third molar* or clavicle* clavicula* or collar bone* or femur or tibia* or fibula* or knee or knees or foot or feet or ankle or ankles) (78361)
#7 (MRI or (MR next imag*) or (magnetic next resonance next imag*) or ct-scan* or cat-scan* or (comput* near/2 tomograp*) or roentgen or x-ray* or xray* or radiolog* or radiograp*) (52159)
#8 #5 and #6 and #7 (236)
#9 (greulich near/2 pyle) (6)
#10 (tanner near/2 whitehouse) (12)
#11 demirjian (11)
#12 haavikko (1)
#13 kullman (17)
#14 nortje (9)
#15 liversidge (9)
#16 kvaal (5)
#17 #1 or #2 or #3 or #4 or #8 or #9 or #10 or #11 or #12 or #13 or #14 or #15 or #16 in Trials (197)

Database: PubMed
Search date: 2016-03-14

Search (((publisher [sb]) OR pubstatusaheadofprint)) AND (((age determinat*[Title/Abstract]) OR age estimat*[Title/Abstract]) OR age assess*[Title/Abstract])	46

Database: Google Scholar
Search date: 2016-03-23

"age estimation" OR "estimation of age" OR "estimating age" OR "age determination" OR "determination of age" OR "determining age" OR "age assessment" OR "assessing age" OR "assessment of age"	Leste første 100 treff.

Database: Clinicaltrials.gov
Dato for søk: 2016-03-15

"age estimation" OR "estimation of age" OR "estimating age" OR "age determination" OR "determination of age" OR "determining age" OR "age assessment" OR "assessing age" OR "assessment of age"	16
greulich OR pyle OR demirjian OR haavikko OR kullman OR nortje OR liversidge OR kvaal	14

Database: WHO - International Clinical Trials Registry Platform (ICTRP)
Dato for søk: 2016-03-15

age estimation OR estimation of age OR estimating age OR age determination OR determination of age OR determining age OR age assessment OR assessing age OR assessment of age	20
greulich OR pyle OR demirjian OR haavikko OR kullman OR nortje OR liversidge OR kvaal	2

Appendix 2: Description of included studies with quality assessment

Boonpitaksathit, T., et al., Dental age assessment of adolescents and emerging adults in United Kingdom Caucasians using censored data for stage H of third molar roots. European Journal of Orthodontics, 2011. 33(5): p. 503-8.		
Population: Country, ethnicity, place and year	Caucasian adolescents and emerging adults who were resident in the London area of the UK, between March 2005 and July 2006 + others from archive	
Age and sex, sample	1223 children, 12.6 to 24.9 years, 63 % girls	
Design of the study	Retrospective cross-sectional	
Index test	Demirjian's stages, 3. Molar	
Aim of the study	"to estimate the mean age of attainment of the four stages (E, F, G, and H) of root development of the third molar. The way in which the end point of completion of stage H can be identified is described."	
QUADAS-2 assessment		
Patient selection method:	Consecutive	
	Rating	**Comment**
- Consecutive or random sample of patients?	YES	
- Avoid inappropriate exclusions?	YES	Exclusion criteria: Patients with medical conditions that might have affected growth and development
DOMAIN 1: Patient selection	LOW RISK	
- Index test interpreted without knowledge of CA?	UNCLEAR	No description of blinding
DOMAIN 2: Index test interpretation	UNCLEAR RISK	
- CA interpreted without knowledge of SA?	Yes	Assumed ok
DOMAIN 3: Reference standard	Low risk	
- All patients included in analysis?	Yes	
DOMAIN 4: Patient flow and timing bias	Low risk	

Elshehawi, W., et al., Dental age assessment of Maltese children and adolescents. Development of a reference dataset and comparison with a United Kingdom Caucasian reference dataset. Journal of Forensic & Legal Medicine, 2016. 39: p. 27-33.	
Population: Country, ethnicity, place and year	Maltese. Radiographic archives from Mater Dei hospital. Unclear data collection period
Age and sex, sample	1593 records of Maltese subjects, 742 males and 851 females, aged between 4 and 26 years
Design of the study	Retrospective cross-sectional study
Index test	Demirjian's stages, 3. molar

Aim of the study	“to develop and validate a reference data set for dental age assessment of the Maltese population and compare the mean age of attainment to UK Caucasian reference data set”	
QUADAS-2		
Patient selection method:	Random	
	Rating	**Comment**
- Consecutive or random sample of patients?	YES	
- Avoid inappropriate exclusions?	YES	Inclusion criteria: Registered Maltese citizens, full dentition, however, patients were also included if they had developmentally absent third molars and missing teeth due to previous extractions. Exclusion criteria: Patients with developmentally missing teeth, apart from developmentally absent third molars and missing teeth due to previous extractions. Cleft lip and/or cleft palate patients or other radiographically apparent craniofacial deformities.
DOMAIN 1: Patient selection	LOW RISK	
- Index test interpreted without knowledge of CA?	YES	Description of blinding. To independent observers
DOMAIN 2: Index test interpretation	LOW RISK	
- CA interpreted without knowledge of SA?	YES	Assumed ok
DOMAIN 3: Reference standard	LOW RISK	
- All patients included in analysis?	YES	
DOMAIN 4: Patient flow and timing bias	LOW RISK	

Guo, Y.C., et al., The influence of impaction to the third molar mineralization in northwestern Chinese population. International Journal of Legal Medicine, 2014. 128(4): p. 659-65.	
Population: Country, ethnicity, place and year	Northwestern Chinese OPGs from the Department of Oral Radiology, the Affiliated Stomatological Hospital of Xi’an Jiaotong University Health Science Center, China from February 2012 to May 2013.
Age and sex, sample	3,512 OPGs of 1,255 male and 2,257 female, aged between 11 and 26 years
Design of the study	Retrospective cross-sectional
Index test	Demirjian’ stages, 3. molar
Aim of the study	“to determine whether the impaction status could delay the chronological process of third molar mineralization in NorthWestern Chinese population too”
QUADAS-2	
Patient selection method:	Random

	Rating	Comment
- Consecutive or random sample of patients?	YES	
- Avoid inappropriate exclusions?	YES	Exclusion criteria: image deformity affecting third molar visualization and orthopantomogram showing obvious dental pathology, such as a third molar dentigerous cyst.
DOMAIN 1: Patient selection	LOW RISK	
- Index test interpreted without knowledge of CA?	YES	Description of blinding One observer per radiograph
DOMAIN 2: Index test interpretation	UNCLEAR RISK	
- CA interpreted without knowledge of SA?	YES	Assumed ok
DOMAIN 3: Reference standard	LOW RISK	
- All patients included in analysis?	YES	
DOMAIN 4: Patient flow and timing bias	LOW RISK	

Guo, Y.C., et al., Chronology of third molar mineralization in a northern Chinese population. Rechtsmedizin, 2015. 25(1): p. 34-39.		
Population: Country, ethnicity, place and year	Northern China, Department of Oral Radiology at the Affiliated Stomatological Hospital of Xi'an Jiaotong University Health Science Center from February 2012 to May 2013.	
Age and sex, sample	3212 radiographs of 1551 males and 1661 females aged from 5 to 25 years	
Design of the study	Retrospective cross-sectional	
Index test	Demirjian' stages, 3. molar	
Aim of the study	"to provide reference data for chronological aging based on mineralization of third molars in a Northern Chinese population"	
QUADAS-2		
Patient selection method:	Unclear	
	Rating	**Comment**
- Consecutive or random sample of patients?	UNCLEAR	
- Avoid inappropriate exclusions?	UNCLEAR	
DOMAIN 1: Patient selection	UNCLEAR RISK	
Index test, conduct and interpretation:		
- Index test interpreted without knowledge of CA?	YES	Description of blinding
DOMAIN 2: Index test interpretation	LOW RISK	
- CA interpreted without	YES	Assumed ok

knowledge of SA?		
DOMAIN 3: Reference standard	LOW RISK	
- All patients included in analysis?	YES	
DOMAIN 4: Patient flow and timing bias?	LOW RISK	

Johan et al., The variability of lower third molar development in Northeast Malaysian population with application to age estimation. JFOS., 2012, 30, 45-54		
Population: Country, ethnicity, place and year	Northeast Malaysia	
Age and sex, sample	1080 subjects (40 males and 540 females) between 14 and 25 years	
Design of the study	Retrospective cross-sectional	
Index test	Demirjian's stages, 3. molar	
Aim of the study	"to assess the variability of the lower third molar (tooth 38 and 48) development in Northeast Malaysian population with respect to the side of dentition, to generate age prediction models and to compare the outcome with other studies."	
QUADAS-2		
Patient selection method:	Unclear	
	Rating	**Comment**
- Consecutive or random sample of patients?	UNCLEAR	
- Avoid inappropriate exclusions?	YES	Exclusion criteria: subjects with obvious dental pathology, known history of chronic medical illness and hormonal deficiency. Non-locals were also excluded.
DOMAIN 1: Patient selection	UNCLEAR RISK	
- Index test interpreted without knowledge of CA?	UNCLEAR	No description of blinding
DOMAIN 2: Index test interpre-tation	UNCLEAR RISK	
- CA interpreted without knowledge of SA?	YES	Assumed OK
DOMAIN 3: Reference standard	LOW RISK	
- All patients included in analysis?	YES	
DOMAIN 4: Patient flow and timing bias?	LOW RISK	

Karadayi, B., et al., The usage of third molars to determine legally relevant age thresholds in Tur-key. Australian Journal of Forensic Sciences, 2015. 47(3): p. 275-282.	
Population: Country, ethnicity, place and year	Turkey, Caucasians
Age and sex, sample	784 between 8 and 23 years (405 females and 379 males)
Design of the study	Cross-sectional

Index test	Demirjian' stages + stage 0 (a radiolucent bud prior to calcification), 3. molar	
Aim of the study		
QUADAS-2		
Patient selection method:	Consecutive	
	Rating	**Comment**
- Consecutive or random sample of patients?	YES	
- Avoid inappropriate exclusions?	YES	Exclusion criteria: Gross pathology, failure of eruption, previous orthodontic treatment, history of metabolic disease
DOMAIN 1: Patient selection	LOW RISK	
Index test, conduct and interpretation:	Inter-observer reliability was tested with re-examination of 70 OPGs 5 weeks after by third author.	
- Index test interpreted without knowledge of CA?	UNCLEAR	No description of blinding
DOMAIN 2: Index test interpretation	UNCLEAR RISK	
- CA interpreted without knowledge of SA?	YES	Assumed OK
DOMAIN 3: Reference standard	LOW RISK	
- All patients included in analysis?	YES	
DOMAIN 4: Patient flow and timing bias?	LOW RISK	

Karataş, O.H., et al., Radiographic evaluation of third-molar development in relation to the chronological age of Turkish children in the southwest Eastern Anatolia region. Forensic Science International, 2013. 232(1): p. 238.e1-5.		
Population: Country, ethnicity, place and year	Turkey, southwest (Eastern Anatolia region)	
Age and sex, sample	832 subjects, 424 males and 408 females, from 6 to 16 years	
Design of the study	Cross-sectional	
Index test	Demirjian' stages, 3. molar	
QUADAS-2		
Patient selection method:	Unclear	
	Rating	**Comment**
- Consecutive or random sample of patients?	UNCLEAR	
- Avoid inappropriate exclusions?	YES	Selection criteria: well nourished and free from any known serious illness, normal growth and dental development, with no impactions, congenital absence or teeth transposition and having all third molars. Exclusion criteria: image deformity affecting the third molars, hypodontia or gross pathology and orthopantomogram showing

		obvious dental pathology, such as a dentigerous cyst associated with a third molar.
DOMAIN 1: Patient selection	UNCLEAR RISK	
- Index test interpreted without knowledge of CA?	UNCLEAR	No description of blinding Two observers
DOMAIN 2: Index test interpretation	UNCLEAR RISK	
- CA interpreted without knowledge of SA?	YES	Assumed OK
DOMAIN 3: Reference standard	LOW RISK	
- All patients included in analysis?	YES	
DOMAIN 4: Patient flow and timing bias?	LOW RISK	

Lee, S.H., et al., Development of third molars in Korean juveniles and adolescents. Forensic Science International, 2009. 188(1): p. 107-11.		
Population: Country, ethnicity, place and year	Korean, OPG taken at Seoul National University Dental Hospital from 2004 to 2005	
Age and sex, sample	3301 subjects (1610 males and 1691 females), 4-26 years, with age 15.2 ± 6.7 and 15.5 ±6.5, respectively	
Design of the study	Cross-sectional	
Index test	Demirjian' stages, 3. molar	
Aim of the study		
QUADAS-2		
Patient selection method:	Random	
	Rating	**Comment**
- Consecutive or random sample of patients?	YES	
- Avoid inappropriate exclusions?	YES	Exclusion criteria: deformity or disturbance of growth influencing the development of teeth or reflected a history of extraction of a third molar
DOMAIN 1: Patient selection	LOW RISK	
- Index test interpreted without knowledge of CA?	UNCLEAR	No description of blinding Two observers
DOMAIN 2: Index test interpretation	UNCLEAR RISK	
- CA interpreted without knowledge of SA?	YES	Assumed ok
DOMAIN 3: Reference standard	LOW RISK	
- All patients included in analysis?	YES	
DOMAIN 4: Patient flow and timing bias?	LOW RISK	

Li, G., et al., Dental age estimation from the developmental stage of the third molars in western

Chinese population. Forensic Science International, 2012. 219(1): p. 158-64.		
Population: Country, ethnicity, place and year	China, Western Chinese juveniles and adolescents. From the Department of Oral Radiology, West China College of Stomatology, Sichuan University. x-rays taken from July 2009 to August 2010.	
Age and sex, sample	989 male and 1089 female Chinese subjects aged between 5 and 23 years, 713 males and 857 females between 10 and 23 years	
Design of the study	Cross-sectional	
Index test	Demirjian's stages with two modifications. Stage 0 was indicating the case of absence and Stage 1 was indicating the radiolucent bud, prior to calcification	
Aim of the study		
QUADAS-2		
Patient selection method:	The radiographs were randomly chosen	
	Rating	**Comment**
- Consecutive or random sample of patients?	YES	Random sample
- Avoid inappropriate exclusions?	YES	Inclusion criteria: OPG of adequate quality, no history of medical or surgical disease that could affect the presence and development of third molars. Exclusion criteria: image deformity affecting third molar visualization, hypodontia, or OPGs showing obvious dental pathology.
DOMAIN 1: Patient selection	LOW RISK	
- Index test interpreted without knowledge of CA?	YES	Without the knowledge of age and gender.
DOMAIN 2: Index test interpretation	LOW RISK	
- CA interpreted without knowledge of SA?	YES	Assumed ok.
DOMAIN 3: Reference standard	LOW RISK	
- All patients included in analysis?	YES	All children included in the analysis.
DOMAIN 4: Patient flow and timing bias?	LOW RISK	

Lopez, T.T., et al., Estimating ages by third molars: Stages of development in Brazilian young adults. Journal of Forensic and Legal Medicine, 2013. 20(5): p. 412-418.	
Population: Country, ethnicity, place and year	Brazil, The X-rays were collected at a private radiology practice in the City of São Paulo serving middle class families in Brazil. Examinations performed during the year of 2010
Age and sex, sample	280 male and 379 female, total 659 Brazilian young adults with ages from 15 to 22 years
Design of the study	Retrospective cross-sectional
Index test	Demirjian' stages, 3. Molar. MST26 and the DT24 used to es-

	tablish the stages of dental element formation.	
Aim of the study		
QUADAS-2		
Patient selection method:	The X-rays were collected at a private radiology practice in the City of São Paulo, Brazil	
	Rating	**Comment**
- Consecutive or random sample of patients?	YES	
- Avoid inappropriate exclusions?	UNCLEAR	Excluded those without the presence of at least one third molar – we are uncertain if this includes those at stage 0. Exclusion criteria: a history of serious illness or abnormal dentition growth.
DOMAIN 1: Patient selection	UNCLEAR RISK	
- Index test interpreted without knowledge of CA?	YES	The investigator had no access to the patients' real age.
DOMAIN 2: Index test interpretation	LOW RISK	
- CA interpreted without knowledge of SA?	YES	Assumed ok
DOMAIN 3: Reference standard	LOW RISK	
- All patients included in analysis?	YES	
DOMAIN 4: Patient flow and timing bias?	LOW RISK	

Meinl, A., et al., On the applicability of secondary dentin formation to radiological age estimation in young adults. Journal of Forensic Sciences, 2007. 52(2): p. 438-41.		
Population: Country, ethnicity, place and year	Austrian male and female individuals. Study conducted between 2002 and 2004 at the Bernhard Gottlieb University Dental Clinic, Vienna.	
Age and sex, sample	610 panoramic radiographs to assess the mineralization status of the mandibular third molars of 275 males and 335 females between the ages of 12 and 24.	
Design of the study	Cross-sectional	
Index test	Demirjian's stages, 3. Molar	
Aim of the study		
QUADAS-2		
Patient selection method:	Random	
	Rating	**Comment**
- Consecutive or random sample of patients?	YES	"Data were collected randomly"
- Avoid inappropriate exclusions?	YES	Assumed ok. Exclusion criteria: non Austrian surname
DOMAIN 1: Patient selection	LOW RISK	
- Index test interpreted without knowledge of CA?	UNCLEAR	One observer. Does not say if first round was blinded.

DOMAIN 2: Index test interpretation	UNCLEAR RISK	
- CA interpreted without knowledge of SA?	YES	Assumed ok
DOMAIN 3: Reference standard	LOW RISK	
- All patients included in analysis?	YES	
DOMAIN 4: Patient flow and timing bias?	LOW RISK	

Olze, A., et al., Studies on the progress of third-molar mineralisation in a Black African population. Homo, 2006. 57(3): p. 209-17.		
Population: Country, ethnicity, place and year	Black South Africans. The investigated radiographs were taken from patients' files of the Department of Oral Pathology and Oral Biology of the University of Pretoria. The radiographic examinations were made between 1992 and 2002.	
Age and sex, sample	595 conventional orthopantomograms of 474 male and 121 female Black Africans aged between 10 and 26 years for whom dates of birth were known.	
Design of the study	Retrospective cross-sectional	
Index test	Demirjian' stages, 3. molar	
Aim of the study		
QUADAS-2		
Patient selection method:	From file at University	
	Rating	**Comment**
- Consecutive or random sample of patients?	UNCLEAR	Not mentioned
- Avoid inappropriate exclusions?	UNCLEAR	
DOMAIN 1: Patient selection	UNCLEAR	
- Index test interpreted without knowledge of CA?	UNCLEAR	No description of blinding
DOMAIN 2: Index test interpretation	UNCLEAR RISK	
- CA interpreted without knowledge of SA?	YES	Assumed ok
DOMAIN 3: Reference standard	LOW RISK	
- All patients included in analysis?	UNCLEAR	
DOMAIN 4: Patient flow and timing bias?	UNCLEAR	

Olze, A., et al., Studies on the chronology of third molar mineralization in First Nations people of Canada. International Journal of Legal Medicine, 2010. 124(5): p. 433-7.	
Population: Country, ethnicity, place and year	First Nations people of Canada, Ojibwa tribe.
Age and sex, sample	605 subjects, 347female and 258 male, from 11 to 29 years
Design of the study	Cross-sectional

Index test	Demirjian' stages, 3. molar	
Aim of the study		
QUADAS-2		
Patient selection method:	Unclear	
	Rating	**Comment**
- Consecutive or random sample of patients?	UNCLEAR	
- Avoid inappropriate exclusions?	UNCLEAR	
DOMAIN 1: Patient selection	UNCLEAR RISK	
- Index test interpreted without knowledge of CA?	UNCLEAR	No description of blinding
DOMAIN 2: Index test interpre-tation	UNCLEAR RISK	
- CA interpreted without knowledge of SA?	YES	Assumed ok
DOMAIN 3: Reference standard	LOW RISK	
- All patients included in analysis?	UNCLEAR	
DOMAIN 4: Patient flow and timing bias?	UNCLEAR RISK	

Olze, A., et al., The influence of impaction on the rate of third molar mineralisation in male black Africans. International Journal of Legal Medicine, 2012. 126(6): p. 869-74.		
Population: Country, ethnicity, place and year	Black South Africans, Department of Oral Pathology and Oral Biology at Pretoria University, period 1992 to 2002.	
Age and sex, sample	553 subjects (437 male and 116 female), 10–26 years	
Design of the study	Cross-sectional	
Index test	Demirjian's stages, 3. Molar	
Aim of the study		
QUADAS-2		
Patient selection method:	**Unclear**	
	Rating	**Comment**
- Consecutive or random sample of patients?	UNCLEAR	
- Avoid inappropriate exclusion	UNCLEAR	
DOMAIN 1: Patient selection	UNCLEAR RISK	
- Index test interpreted without knowledge of CA?	YES	
DOMAIN 2: Index test interpre-tation	LOW RISK	Description of blinding
- CA interpreted without knowledge of SA?	YES	
DOMAIN 3: Reference standard	LOW RISK	Assumed ok
- All patients included in analy-sis?	UNCLEAR	
DOMAIN 4: Patient flow and	UNCLEAR RISK	

timing bias?		

Prieto, J.L., et al., Evaluation of chronological age based on third molar development in the Spanish population. International Journal of Legal Medicine, 2005. 119(6): p. 349-54.		
Population: Country, ethnicity, place and year	Spanish, collected over nine months, unclear which year	
Age and sex, sample	The final sample consisted of 1,054 orthopantomograms from Spanish individuals of known chronological age (range 14–21 years) and gender (462 males and 592 females).	
Design of the study	Cross-sectional	
Index test	Demirjian's stages, 3. Molar	
Aim of the study		
QUADAS-2		
Patient selection method:	random	
	Rating	**Comment**
- Consecutive or random sample of patients?	YES	Random selection
- Avoid inappropriate exclusions?	UNCLEAR	Exclusion criteria: Third mandibular molars missing, unclear if lack of third molar also include stage 0. Image deformity affecting third molars and Orthopantomogram showing obvious dental pathology
DOMAIN 1: Patient selection	UNCLEAR RISK	
- Index test interpreted without knowledge of CA?	UNCLEAR	No description of blinding
DOMAIN 2: Index test interpretation	UNCLEAR RISK	
- CA interpreted without knowledge of SA?	YES	Assumed ok
DOMAIN 3: Reference standard	LOW RISK	
- All patients included in analysis?	YES	
DOMAIN 4: Patient flow and timing bias?	LOW RISK	

Rouge-Maillart, C., et al., Estimation of the age of 15-25 year-olds using Dermirjian's dental technique. Study of a population from the West, France. Revue de Medecine Legale, 2011. 2(3): p. 117-124.	
Population: Country, ethnicity, place and year	White European children treated at Angers University Hospital, France. Year unknown
Age and sex, sample	209 children between 11 and 26 years, 115 girls and 94 boys
Design of the study	Cross-sectional
Index test	Demirjian's stages, 3. Molar
Patient selection method:	Consecutive sample

Aim of the study		
QUADAS-2		
	Rating	**Comment**
- Consecutive or random sample of patients?	YES	Consecutive
- Avoid inappropriate exclusions?	NO	Inclusion criteria: All four M3 present, at least one in apexogonesis, absence of dental development anomalities and abcence of dental care that could have modified the emergence of the wisdom teeth
DOMAIN 1: Patient selection	HIGH RISK	
Index test, conduct and interpretation:	Demirjian's stages, 3. Molar (stages C-H)	
- Index test interpreted without knowledge of CA?	UNCLEAR	No description of blinding
DOMAIN 2: Index test interpretation	UNCLEAR RISK	
- CA interpreted without knowledge of SA?	YES	Assumed ok
DOMAIN 3: Reference standard	LOW RISK	
- All patients included in analysis?	NO	Those with closed apex in all four wisdom teeth were excluded
DOMAIN 4: Patient flow and timing bias?	HIGH RISK	

Zandi, M., et al., Evaluation of third molar development and its relation to chronological age: a panoramic radiographic study. Oral & Maxillofacial Surgery, 2015. 19(2): p. 183-9.		
Population: Country, ethnicity, place and year	Various private dental clinics of Iran. Only orthopantomograms with known age and gender were included in the study. Year unknown.	
Age and sex, sample	A total of 2536 digital panoramic radiographs of individuals aged between 5 and 26 years were selected. 1991 persons between 10 and 25	
Design of the study	Cross-sectional	
Index test	Demirjian's stages, 3. Molar (added stage 0)	
Aim of the study		
QUADAS-2		
Patient selection method:	Random	
	Rating	**Comment**
- Consecutive or random sample of patients?	YES	Random
- Avoid inappropriate exclusions?	YES	Exclusion criteria: image deformity and gross pathology affecting the area of interest,hypodontia, and radiographs showing any anomaly or systemic disease influencing the tooth development

DOMAIN 1: Patient selection	LOW RISK	
Index test, conduct and interpretation:	The developmental status of the third molars was assessed using eight-stage developmental scoring proposed by Demirjian et al., with one modification: a stage 0 was added.	
- Index test interpreted without knowledge of CA?	YES	Description of blinding. Two well trained examiners.
DOMAIN 2: Index test interpretation	LOW RISK	
- CA interpreted without knowledge of SA?	YES	Assumed ok
DOMAIN 3: Reference standard	LOW RISK	
- All patients included in analysis?	YES	
DOMAIN 4: Patient flow and timing bias?	LOW RISK	

Zeng, D.L., Z.L. Wu, and M.Y. Cui, Chronological age estimation of third molar mineralization of Han in southern China. International Journal of Legal Medicine, 2010. 124(2): p. 119-23.		
Population: Country, ethnicity, place and year	Han in southern China. The radiological examinations were performed from January 2008 to June 2009.	
Age and sex, sample	3,100 subjects aged 4.1–26.9 years	
Design of the study	Cross-sectional	
Index test	Demirjian's stages, 3. Molar	
Aim of the study		
QUADAS-2		
Patient selection method:	UNCLEAR	
	Rating	**Comment**
- Consecutive or random sample of patients?	UNCLEAR	
- Avoid inappropriate exclusions?	YES	Inclusion criteria: Southern Chinese and Han residence, well nourished and free of any known serious illness, normal growth and development and dental conditions. Exclusion criteria: All third molars lost, image deformity affecting third molars and OPGs showing obvious dental pathology, such as dentigerous cyst of third molar In 53 cases, all four third molars were lost, so these cases were excluded.
DOMAIN 1: Patient selection	UNCLEAR RISK	
- Index test interpreted without knowledge of CA?	UNCLEAR	No description of blinding. Two observers
DOMAIN 2: Index test interpretation	UNCLEAR RISK	
- CA interpreted without knowledge of SA?	YES	Assumed ok
DOMAIN 3: Reference standard	LOW RISK	

- All patients included in analysis?	YES	
DOMAIN 4: Patient flow and timing bias?	LOW RISK	

Appendix 3: Relevant datasets using Demirjian's staging methods

After the statistical analyses were completed, we identified further two studies that fulfilled the inclusion criteria in this systematic review:

- Nur BG, Altunsoy M, Akkemik O, Ok E, Evcil MS. Third-molar mineralization and eruption correlated to chronologic age in Turkish children and adolescents. Australian Journal of Forensic Sciences. 2015;47(3):313-21.
- Qing M, Qiu L, Gao Z, Bhandari K. The chronological age estimation of third molar mineralization of Han population in southwestern China. Journal of forensic and legal medicine. 2014;24:24-7.

In addition to the 18 included studies and the 2 studies above, we identified 213 studies with data on dental age or maturation stages based on Demirjian's stages and had data on chronological age. The population criteria appear to be fulfilled, i.e. data for more than 50 healthy children in the age range 10-26 years. In this table, we do not distinguish between studies using Demirjian's original system on the first seven teeth (3), Demirjian's stages of the third molar or other teeth alone or combined. The studies listed below were not included in this systematic review because 1) they did not provide data on the third molar or 2) the article did not provide the relevant figures or analyses. Some of these studies were analysed with regard to other objectives than ours. We have gathered information about these studies because they may represent potential relevant datasets for further analyses. Some of these studies have used more than one scoring method on the same subjects as described.

Reference	Country	No. of participants	Age range
Abesi, F., et al., *Assessment of dental maturity of children aged 7-15 years using demirjian method in a selected Iranian population.* Journal of Dentistry, 2013. **14**(4): p. 165-9.	Iran	168	7-15 years
Abesi, F., et al., *Association between body mass index and dental development in 7-15 year old children and adolescents in the city of Babol-Iran (2011). [Persian].* Journal of Babol University of Medical Sciences, 2013. **15**(5): p. 52-58.	Iran	168	7-15 years
Abu Asab, S., S.N. Noor, and M.F. Khamis, *The accuracy of demirjian method in dental age estimation of malay children.* Singapore Dental Journal, 2011. **32**(1): p. 19-27.	Malaysia	905	6-16 years
Acharya, A.B., *Accuracy of predicting 18 years of age from mandibular third molar development in an Indian sample using Demirjian's ten-stage criteria.* International Journal of Legal Medicine, 2011. **125**(2): p. 227-33.	India	221	15-21 years
Acharya, A.B., *Age estimation in Indians using Demirjian's 8-teeth method.* Journal of Forensic Sciences, 2011. **56**(1): p. 124-7.	India	547	7-25 years
Agathos D, Markostamos K, Toutountjakis N. Statural, bone and dental growth in Greek girls of the Athenian region. [French]. L' Orthodontie francaise. 1987;58:507-16.	Greece	151	6-17 years
Aissaoui, A., et al., Dental age assessment among Tunisian children using the Demirjian method. Journal of forensic dental sciences : JFDS, 2016. 8(1): p. 47-51.	Tunisia	280	3-17 years

Ajmal, M., et al., *Age estimation using third molar teeth: A study on southern Saudi population.* Journal of forensic dental sciences : JFDS, 2012. **4**(2): p. 63-5.	Saudi Arabia	360	13-23 years
Akkaya, N., H.O. Yilanci, and D. Goksuluk, *Applicability of Demirjian's four methods and Willems method for age estimation in a sample of Turkish children.* Legal Medicine, 2015. **17**(5): p. 355-9.	Turkey	799	2-16 years
Al-Emran, S., *Dental age assessment of 8.5 to 17 Year-old Saudi children using Demirjian's method.* Journal of Contemporary Dental Practice [Electronic Resource], 2008. **9**(3): p. 64-71.	Denmark	365	6-19 years
Almeida, M.S., et al., *The chronology of second molar development in Brazilians and its application to forensic age estimation.* Imaging Science in Dentistry, 2013. **43**(1): p. 1-6.	Brazil	457	5-16 years
Alqahtani, S.J., H.M. Liversidge, and M.P. Hector, *Atlas of tooth development and eruption.* American Journal of Physical Anthropology, 2010. **141**: p. 54.	Saudi Arabia	130	14-23 years
Altalie, S., et al., *Optimal dental age estimation practice in United Arab Emirates' children.* Journal of Forensic Sciences, 2014. **59**(2): p. 383-5.	United Arab Emirates	1900	4-23 years
Altunsoy, M., et al., *Applicability of the Demirjian method for dental age estimation in western Turkish children.* Acta Odontologica Scandinavica, 2015. **73**(2): p. 121-5.	Turkey	635	7-16 years
Al-Tuwirqi, A., T. Holcombe, and W.K. Seow, *A study of dental development in a Caucasian population compared with a non-Caucasian population.* European Archives of Paediatric Dentistry: Official Journal of the European Academy of Paediatric Dentistry, 2011. **12**(1): p. 26-30.	Saudi Arabia, Australia	1298	6-14 years
Ambarkova, V., et al., *Dental age estimation using Demirjian and Willems methods: cross sectional study on children from the Former Yugoslav Republic of Macedonia.* Forensic Science International, 2014. **234**: p. 187.e1-7.	Macedonia	966	6-13 years
Andersen, E., et al., *The influence of jaw innervation on the dental maturation pattern in the mandible.* Orthodontics & Craniofacial Research, 2004. **7**(4): p. 211-5.	Denmark	365	6-16 years
Arany, S., M. Iino, and N. Yoshioka, *Radiographic survey of third molar development in relation to chronological age among Japanese juveniles.* Journal of Forensic Sciences, 2004. **49**(3): p. 534-8.	Japan	1282	14-24 years
Ardakani, F., N. Bashardoust, and M. Sheikhha, *The accuracy of dental panoramic radiography as an indicator of chronological age in Iranian individuals.* Journal of Forensic Odonto-Stomatology, 2007. **25**(2): p. 30-5.	Iran	58	15-25 years
Baba-Kawano, S., et al., *Relationship between congenitally missing lower third molars and late formation of tooth germs.* Angle Orthodontist, 2002. **72**(2): p. 112-7.	Japan	96	6-17 years
Babburi, S., et al., *Radiographic Estimation of Chronological Age using Mineralization of Third Molars in Coastal Andhra, India.* Journal of International Oral Health, 2015. **7**(5): p. 49-52.	India	550	15-22 years
Baghdadi ZD, Pani SC. Accuracy of population-specific Demirjian curves in the estimation of dental age of Saudi children. International Journal of Paediatric Dentistry. 2012;22(2):125-31.	Saudi Arabia	176	4-14 years
Baghdadi, Z.D., *Dental maturity in saudi children using the*	Saudi Ara-	422	4-14 years

demirjian method: a comparative study and new prediction models. ISRN Dentistry, 2013. **2013**: p. 390314.	bia		
Baghdadi, Z.D., *Dental maturity of Saudi children: Role of ethnicity in age determination.* Imaging Science in Dentistry, 2013. **43**(4): p. 267-72.	Saudi Arabia	452	4-14 years
Baghdadi, Z.D., *Testing international dental maturation scoring system and population-specific Demirjian versions on Saudi sub-population.* Journal of Clinical & Experimental Dentistry, 2014. **6**(2): p. e138-44.	Saudi Arabia	252	4-14 years
Bagherian, A. and M. Sadeghi, *Assessment of dental maturity of children aged 3.5 to 13.5 years using the Demirjian method in an Iranian population.* Journal of Oral Science, 2011. **53**(1): p. 37-42.	Iran	519	3-14 years
Bagherpour, A., et al., *Dental age assessment among Iranian children aged 6-13 years using the Demirjian method.* Forensic Science International, 2010. **197**(1): p. 121.e1-4.	Iran	311	6-13 years
Balaraj, B.M. and M.D. Nithin, *Determination of adolescent ages 14-16 years by radiological study of permanent mandibular second molars.* Journal of Forensic and Legal Medicine, 2010. **17**(6): p. 329-332.	India	116	13-18 years
Basaran, G., T. Ozer, and N. Hamamci, *Cervical vertebral and dental maturity in Turkish subjects.* American Journal of Orthodontics and Dentofacial Orthopedics, 2007. **131**(4): p. 447.e13-447.e20.	Turkey	590	7-18 years
Bijjaragi, S.C., et al., *Age estimation by modified Demirjian's method (2004) and its applicability in Tibetan young adults: A digital panoramic study.* Journal of Oral & Maxillofacial Pathology, 2015. **19**(1): p. 100-5.	Tibet	300	8-18 years
Blankenship, J.A., et al., *Third molar development in the estimation of chronologic age in american blacks as compared with whites.* Journal of Forensic Sciences, 2007. **52**(2): p. 428-33.	USA	1201	14-24 years
Blenkin, M.R. and W. Evans, *Age estimation from the teeth using a modified Demirjian system.* Journal of Forensic Sciences, 2010. **55**(6): p. 1504-8.	Australia	3261	0-24 years
Braga, J., et al., *Non-adult dental age assessment: correspondence analysis and linear regression versus Bayesian predictions.* International Journal of Legal Medicine, 2005. **119**(5): p. 260-74.	Ivory coast, Iran, France	1528	4-16 years
Burt, N.M., N. Sauer, and T. Fenton, *Testing the Demirjian and the international Demirjian dental aging methods on a mixed ancestry urban American subadult sample from Detroit, MI.* Journal of Forensic Sciences, 2011. **56**(5): p. 1296-301.	USA	187	6-23 years
Caldas, I.M., et al., *Chronological age estimation based on third molar development in a Portuguese population.* International Journal of Legal Medicine, 2011. **125**(2): p. 235-43.	Portugal	739	6-23 years
Cameriere, R., et al., *Effects of nutrition on timing of mineralization in teeth in a Peruvian sample by the Cameriere and Demirjian methods.* Annals of Human Biology, 2007. **34**(5): p. 547-56.	Peru	287	10-17 years
Cameriere, R., et al., *The comparison between measurement of open apices of third molars and Demirjian stages to test chronological age of over 18 year olds in living subjects.* International	Italy	906	14-23 years

Journal of Legal Medicine, 2008. **122**(6): p. 493-7.			
Cantekin, K., et al., *Dental age assessment for different climatic regions.* American Journal of Forensic Medicine & Pathology, 2014. **35**(3): p. 197-200.	Turkey	944	7-15 years
Cantekin, K., et al., *Morphologic analysis of third-molar mineralization for eastern Turkish children and youth.* Journal of Forensic Sciences, 2012. **57**(2): p. 531-4.	Turkey	1348	7-22 years
Carneiro, J.L., et al., *Is Demirjian's original method really useful for age estimation in a forensic context?* Forensic Science, Medicine & Pathology, 2015. **11**(2): p. 216-21.	Portugal	564	6-16 years
Cavric, J., et al., *Time of mineralization of permanent teeth in children and adolescents in Gaborone, Botswana.* Annals of Anatomy, 2016. **203**: p. 24-32.	Botswana	1760	6-23 years
Celik, S., et al., *Applicability of the Demirjian method for dental assessment of southern Turkish children.* Journal of Forensic & Legal Medicine, 2014. **25**: p. 1-5.	Turkey	932	4-18 years
Celikoglu, M., K. Cantekin, and I. Ceylan, *Dental age assessment: the applicability of Demirjian method in eastern Turkish children.* Journal of Forensic Sciences, 2011. **56**: p. S220-2.	Turkey	807	7-15 years
Chaillet, N. and A. Demirjian, *Dental maturity in South France: A comparison between Demirjian's method and polynomial functions.* Journal of Forensic Sciences, 2004. **49**(5): p. 1059-66.	France	1031	2-18 years
Chaillet, N., et al., *Dental maturity curves in Finnish children: Demirjian's method revisited and polynomial functions for age estimation.* Journal of Forensic Sciences, 2004. **49**(6): p. 1324-31.	Finland	2213	2-19 years
Chaillet, N., G. Willems, and A. Demirjian, *Dental maturity in Belgian children using Demirjian's method and polynomial functions: new standard curves for forensic and clinical use.* Journal of Forensic Odonto-Stomatology, 2004. **22**(2): p. 18-27.	Belgium	2523	2-18 years
Chaillet, N., M. Nystrom, and A. Demirjian, *Comparison of dental maturity in children of different ethnic origins: international maturity curves for clinicians.* Journal of Forensic Sciences, 2005. **50**(5): p. 1164-74.	8 countries	9577	2-25 years
Chen, J.W., et al., *Assessment of dental maturity of western Chinese children using Demirjian's method.* Forensic Science International, 2010. **197**(1): p. 119.e1-4.	China	445	8-16 years
Chudasama, P.N., G.J. Roberts, and V.S. Lucas, *Dental age assessment (DAA): A study of a Caucasian population at the 13 year threshold.* Journal of Forensic and Legal Medicine, 2012. **19**(1): p. 22-28.	UK	5187	11-15 years
Corradi, F., et al., *Optimal age classification of young individuals based on dental evidence in civil and criminal proceedings.* International Journal of Legal Medicine, 2013. **127**(6): p. 1157-64.	Italy	1560	15-22 years
Corradi, F., et al., *Probabilistic classification of age by third molar development: the use of soft evidence.* Journal of Forensic Sciences, 2013. **58**(1): p. 51-9.	Italy	559	16-22 years
Cossellu, G., et al., *Relationship between mandibular second molar calcification stages and cervical vertebrae maturity in Italian children and young adults.* European journal of paediatric dentistry : official journal of European Academy of Paediat-	Italy	500	10-20 years

ric Dentistry, 2014. **15**(4): p. 355-359.			
Costa, J., et al., *Accuracy in the legal age estimation according to the third molars mineralization among Mexicans and Columbians.* Atencion Primaria, 2014. **46**: p. 165-75.	Colombia, Mexico	316	8-25 years
Cruz-Landeira, A., et al., *Dental age estimation in Spanish and Venezuelan children. Comparison of Demirjian and Chaillet's scores.* International Journal of Legal Medicine, 2010. **124**(2): p. 105-12.	Spain, Venezuela	508	2-18 years
Davidson, L.E. and H.D. Rodd, *Interrelationship between dental age and chronological age in Somali children.* Community Dental Health, 2001. **18**(1): p. 27-30.	Somalia	162	4-16 years
de Oliveira, F.T., et al., *Mineralization of mandibular third molars can estimate chronological age-Brazilian indices.* Forensic Science International, 2012. **219**(1): p. 147-150.	Brazil	407	6-25 years
De Salvia, A., et al., *Third mandibular molar radiological development as an indicator of chronological age in a European population.* Forensic Science International, 2004. **146**: p. S9-S12.	Spain	400	14-25 years
Demirjian, A. and G.Y. Levesque, *Sexual differences in dental development and prediction of emergence.* Journal of Dental Research, 1980. **59**(7): p. 1110-22.	Canada	5437	2-19 years
Demirjian, A. and H. Goldstein, *New systems for dental maturity based on seven and four teeth.* Annals of Human Biology, 1976. **3**(5): p. 411-21.	Canada	4766	3-17 years
Demirjian, A., *[Dental development: an index of physiological maturity].* Union Medicale du Canada, 1980. **109**(6): p. 832-9.	Canada	5437	2-19 years
Demirjian, A., H. Goldstein, and J.M. Tanner, *A new system of dental age assessment.* Human Biology, 1973. **45**(2): p. 211-27.	Canada	2694	2-20 years
Demirturk Kocasarac, H., et al., *Radiologic assessment of third molar tooth and spheno-occipital synchondrosis for age estimation: a multiple regression analysis study.* International Journal of Legal Medicine, 2016. **130**(3): p. 799-808.	Turkey	349	8-25 years
Dhanjal, K.S., M.K. Bhardwaj, and H.M. Liversidge, *Reproducibility of radiographic stage assessment of third molars.* Forensic Science International, 2006. **159**: p. S74-7.	UK	73	8-24 years
Diz, P., et al., *Correlation between dental maturation and chronological age in patients with cerebral palsy, mental retardation, and Down syndrome.* Research in Developmental Disabilities, 2011. **32**(2): p. 808-17.	Spain	688	3-17 years
Djukic, K., et al., *Dental age assessment validity of radiographic methods on Serbian children population.* Forensic Science International, 2013. **231**(1): p. 398.e1-5.	Serbia	686	4-15 years
Eid, R.M., et al., *Assessment of dental maturity of Brazilian children aged 6 to 14 years using Demirjian's method.* International journal of paediatric dentistry / the British Paedodontic Society [and] the International Association of Dentistry for Children, 2002. **12**(6): p. 423-428.	Brazil	689	6-18 years
Ercalikyalcinkaya, S., et al., *Demirjian's system for estimating dental age among Northwestern Turkish children aged 4-16 years.* European Journal of Paediatric Dentistry, 2013. **14**(3): p. 225-30.	Turkey	1678	4-16 years
Erdem, A.P., et al., *A new method to estimate dental age.* Acta Odontologica Scandinavica, 2013. **71**(3): p. 590-8.	Turkey	756	5-13 years

Esenlik, E., A. Atak, and C. Altun, *Evaluation of dental maturation in children according to sagittal jaw relationship.* European journal of dentistry, 2014. **8**(1): p. 38-43.	Turkey	221	7-16 years
Farah, C.S., D.R. Booth, and S.C. Knott, *Dental maturity of children in Perth, Western Australia, and its application in forensic age estimation.* Journal of Clinical Forensic Medicine, 1999. **6**(1): p. 14-8.	Australia	1450	4-16 years
Feijoo, G., et al., *Dental age estimation in Spanish children.* Forensic Science International, 2012. **223**(1): p. 371.e1-5.	Spain	1010	2-16 years
Feijoo, G., et al., *Permanent teeth development in a Spanish sample. Application to dental age estimation.* Forensic Science International, 2012. **214**(1): p. 213.e1-6.	Spain	1010	2-16 years
Flood, S.J., et al., *A comparison of Demirjian's four dental development methods for forensic age assessment.* Journal of Forensic Sciences, 2011. **56**(6): p. 1610-5.	Australia	143	5-15 years
Flood, S.J., et al., *A comparison of Demirjian's four dental development methods for forensic age estimation in South Australian sub-adults.* Journal of Forensic and Legal Medicine, 2013. **20**(7): p. 875-883.	Australia	408	5-15 years
Flood, S.J., et al., *To evaluate the utility of smaller sample sizes when assessing dental maturity curves for forensic age estimation.* Journal of Forensic Sciences, 2011. **56**(6): p. 1604-9.	Australia	144	4-15 years
Flores, A.P., et al., *Study of Chilean children's dental maturation.* Journal of Forensic Sciences, 2010. **55**(3): p. 735-7.	Chile	159	3-14 years
Foti, B., et al., *[Probabilistic approach to age estimation of children by dental maturation].* Comptes Rendus Biologies, 2003. **326**(4): p. 441-8.	France	810	6-21 years
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Frucht, S., et al., *Dental age in southwest Germany. A radiographic study.[Erratum appears in J Orofac Orthop 2000;61(6):450].* Journal of Orofacial Orthopedics, 2000. **61**(5): p. 318-29.	Germany	1003	2-20 years
Galic I, Nakas E, Prohic S, Selimovic E, Obradovic B, Petrovecki M. Dental age estimation among children aged 5-14 years using the demirjian method in Bosnia-Herzegovina. [Croatian, English]. Acta Stomatologica Croatica. 2010;44(1):17-25.	Bosnia and Herzegovina	1106	5-14 years
Garamendi PM, Landa MI, Ballesteros J, Solano MA. Reliability of the methods applied to assess age minority in living subjects around 18 years old. A survey on a Moroccan origin population. Forensic Science International. 2005;154(1):3-12.	Moroccan	114	13-25 year
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Ginzelova, K., et al., *Using Dental Age to Estimate Chronological Age in Czech Children Aged 3-18 Years.* Prague Medical Report, 2015. **116**(2): p. 139-54.	Czech republic	505	3-18 years
Goyal, S., S. Goyal, and N. Gugnani, *Assessment of skeletal maturation using mandibular second molar maturation stages.* Journal of Clinical Pediatric Dentistry, 2014. **39**(1): p. 79-84.	Rwanda	209	7-18 years
Grover, S., et al., *Estimation of dental age and its comparison with chronological age: Accuracy of two radiographic methods.* Medicine, Science and the Law, 2012. **52**(1): p. 32-35.	India	151	6–15 years
Gungor, O.E., et al., *Validity of the Demirjian method for dental age estimation for Southern Turkish children.* Nigerian Journal of Clinical Practice, 2015. **18**(5): p. 616-9.	Turkey	535	10-18 years
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Hegde, R.J., et al., *Evaluation of the accuracy of Demirjian method for estimation of dental age among 6-12 years of children in Navi Mumbai: A radiographic study.* Journal of the Indian Society of Pedodontics & Preventive Dentistry, 2015. **33**(4): p. 319-23.	India	197	6-12 years
Heravi, F., M. Imanimoghaddam, and H. Rahimi, *Correlation between cervical vertebral and dental maturity in Iranian subjects.* Journal of the California Dental Association, 2011. **39**(12): p. 891-6.	Iran	120	10-15 years
Hilgers, K.K., et al., *Childhood obesity and dental development.* Pediatric Dentistry, 2006. **28**(1): p. 18-22.	USA	104	8-15 years
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Introna, F., et al., *Morphologic analysis of third-molar maturity by digital orthopantomographic assessment.* American Journal of Forensic Medicine & Pathology, 2008. **29**(1): p. 55-61.	Italy	83	16-22 years
Jamroz, G.M., et al., *Dental maturation in short and long facial types. Is there a difference?* Angle Orthodontist, 2006. **76**(5): p. 768-72.	Netherland	312	9-12.9 years
Javadinejad, S., H. Sekhavati, and R. Ghafari, *A Comparison of the Accuracy of Four Age Estimation Methods Based on Panoramic Radiography of Developing Teeth.* Journal of Dental Research Dental Clinics Dental Prospects, 2015. **9**(2): p. 72-8.	Iran	577	3.9-14.5 years
Jayaraman, J., et al., *Dental age assessment of southern Chinese using the United Kingdom Caucasian reference dataset.*	China	266	2-21 years

Forensic Science International, 2012. **216**(1): p. 68-72.			
Jayaraman, J., et al., *Dental age assessment: are Demirjian's standards appropriate for southern Chinese children?* Journal of Forensic Odonto-Stomatology, 2011. **29**(2): p. 22-8.	China	182	3-16
Karadayi, B., et al., *Development of dental charts according to tooth development and eruption for Turkish children and young adults.* Imaging Science in Dentistry, 2014. **44**(2): p. 103-13.	Turkey	753	4.5-22.5 years
Kasper, K.A., et al., *Reliability of third molar development for age estimation in a Texas Hispanic population: a comparison study.* Journal of Forensic Sciences, 2009. **54**(3): p. 651-7.	USA	950	12-22 years
Kataja, M., M. Nystrom, and L. Aine, *Dental maturity standards in southern Finland.* Proceedings of the Finnish Dental Society, 1989. **85**(3): p. 187-97.	Finland	1062	2-17 years
Kedarisetty, S.G., et al., *Evaluation of skeletal and dental age using third molar calcification, condylar height and length of the mandibular body.* Journal of forensic dental sciences: JFDS, 2015. **7**(2): p. 121-5.	India	60	~18 years
Khoja, A., M. Fida, and A. Shaikh, *Validity of different dental age estimation methods in Pakistani orthodontic patients.* Australian Journal of Forensic Sciences, 2015. **47**(3): p. 283-292.	Pakistan	403	8-17 years
Khorate, M.M., A.D. Dinkar, and J. Ahmed, *Accuracy of age estimation methods from orthopantomograph in forensic odontology: a comparative study.* Forensic Science International, 2014. **234**: p. 184.e1-8.	India	500	4-21.1 years
Kiran Ch, S., et al., *Radiographic evaluation of dental age using Demirjian's eight-teeth method and its comparison with Indian formulas in South Indian population.* Journal of forensic dental sciences: JFDS, 2015. **7**(1): p. 44-8.	India	250	7-18 years
Kirzioglu, Z. and D. Ceyhan, *Accuracy of different dental age estimation methods on Turkish children.* Forensic Science International, 2012. **216**(1): p. 61-7.	Turkey	200	6-13 years
Knell, B., et al., *Dental age diagnostics by means of radiographical evaluation of the growth stages of lower wisdom teeth.* International Journal of Legal Medicine, 2009. **123**(6): p. 465-9.	Switzerland	1260	15-22 years
Koshy, S. and S. Tandon, *Dental age assessment: the applicability of Demirjian's method in south Indian children.* Forensic Science International, 1998. **94**(1): p. 73-85.	India	184	5-15 years
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Kumar, S., et al., *Skeletal maturation evaluation using mandibular second molar calcification stages.* Angle Orthodontist, 2012. **82**(3): p. 501-6.	India	300	9-18 years
Kumar, V.J. and K.S. Gopal, *Reliability of age estimation using Demirjian's 8 teeth method and India specific formula.* Journal of forensic dental sciences: JFDS, 2011. **3**(1): p. 19-22.	India	115	7-23
Lee, S.E., et al., *Age estimation of Korean children based on dental maturity.* Forensic Science International, 2008. **178**(2):	Korea	2706	1-20 years

p. 125-31.			
Lee, S.S., et al., *The chronology of second and third molar development in Koreans and its application to forensic age estimation.* International Journal of Legal Medicine, 2010. **124**(6): p. 659-65.	Korea	2087	3-23 years
Lee, S.S., et al., *Validity of Demirjian's and modified Demirjian's methods in age estimation for Korean juveniles and adolescents.* Forensic Science International, 2011. **211**(1): p. 41-6.	Korea	700	3-15 years
Leurs, I.H., et al., *Dental age in Dutch children.* European Journal of Orthodontics, 2005. **27**(3): p. 309-14.	Netherland	451	3-17 years
Lewis, A.J., et al., *Demirjian's method in the estimation of age: A study on human third molars.* Journal of forensic dental science : JFDS, 2015. **7**(2): p. 153-7.	Indian	115	14-22 years
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Liversidge, H.M., et al., *Timing of Demirjian's tooth formation stages.* Annals of Human Biology, 2006. **33**(4): p. 454-70.	Several countries	9002	2-16.99 years
Liversidge, H.M., *Interpreting group differences using Demirjian's dental maturity method.* Forensic Science International, 2010. **201**(1): p. 95-101.	Several countries	8040	2-18 years
Loevy, H.T., *Maturation of permanent teeth in Black and Latino children.* Acta de Odontologia Pediatrica, 1983. **4**(2): p. 59-62.	USA	1085	2-15 years
Lu Y. Relationships between mandibular canine calcification stages and skeletal maturity. [Chinese]. Zhonghua kou qiang yi xue za zhi = Zhonghua kouqiang yixue zazhi = Chinese journal of stomatology, 1999. 34(1): p. 40-2.	China	258	7 to 15 years
Maber, M., H.M. Liversidge, and M.P. Hector, *Accuracy of age estimation of radiographic methods using developing teeth.* Forensic Science International, 2006. **159**: p. S68-73.	UK	946	3-16.99 years
Mack, K.B., et al., *Relationship between body mass index percentile and skeletal maturation and dental development in orthodontic patients.[Erratum appears in Am J Orthod Dentofacial Orthop. 2013 Apr;143(4):448].* American Journal of Orthodontics & Dentofacial Orthopedics, 2013. **143**(2): p. 228-34.	USA	540	8-17 years
Maia, M.C., et al., *Demirjian's system for estimating the dental age of northeastern Brazilian children.* Forensic Science International, 2010. **200**(1): p. 177.e1-4.	Brazil	1491	7-13 years
Makkad RS, Balani A, Chaturvedi SS, Tanwani T, Agrawal A, Hamdani S. Reliability of panoramic radiography in chronological age estimation. Journal of forensic dental sciences: JFDS. 2013. 5(2): p. 129-33.	India	270	17-25 years
Malik P, Rana V, Rehani U. To Evaluate the Relationship between Mandibular Canine Calcification Stages and Skeletal Age. Jaypees International Journal of Clinical Pediatric Dentistry. 2012. 5(1): p. 14-9.	India	147	10-13 years
Malik, P., R. Saha, and A. Agarwal, *Applicability of Demirjian's method of age assessment in a North Indian female population.* European journal of paediatric dentistry: official journal of European Academy of Paediatric Dentistry, 2012. **13**(2): p. 133-135.	India	100	8-14

Mani, S.A., et al., *Comparison of two methods of dental age estimation in 7-15-year-old Malays.* International Journal of Paediatric Dentistry, 2008. **18**(5): p. 380-8.	Malaysia	428	7-15 years
Mao, J., et al., *Third-molar development in relation to chronologic age in young adults of central China.* Journal of Huazhong University of Science and Technology - Medical Science, 2008. **28**(4): p. 487-490.	China	291	8-20 years
Martin-de las Heras, S., et al., *Third molar development according to chronological age in populations from Spanish and Magrebian origin.* Forensic Science International, 2008. **174**(1): p. 47-53.	Spain	572	14-22.96 years
McKenna, C.J., et al., *Tooth development standards for South Australia.* Australian Dental Journal, 2002. **47**(3): p. 223-7.	Australia	615	4.9-16.9 years
Medina, A.C. and L. Blanco, *Accuracy of dental age estimation in Venezuelan children: comparison of Demirjian and Willems methods.* Acta Odontologica Latinoamericana, 2014. **27**(1): p. 34-41.	Venezuela	238	5-13 years
Mincer, H.H., E.F. Harris, and H.E. Berryman, *The A.B.F.O. study of third molar development and its use as an estimator of chronological age.* Journal of Forensic Sciences, 1993. **38**(2): p. 379-390.	USA	823	14-24 years
Mitchell, J.C., et al., *Dental age assessment (DAA): reference data for British caucasians at the 16 year threshold.* Forensic Science International, 2009. **189**(1): p. 19-23.	UK	1722	4-24 years
Moananui, R.T., et al., *Advanced dental maturation in New Zealand Maori and Pacific Island children.* American Journal of Human Biology, 2008. **20**(1): p. 43-50.	New Zealand	1343	2.5-14 years
Mohammed, R.B., et al., *Accuracy of four dental age estimation methods in Southern Indian children.* Journal of Clinical and Diagnostic Research, 2015. **9**(1): p. HC01-HC08.	India	554	6-16 years
Mohammed, R.B., et al., *Digital radiographic evaluation of mandibular third molar for age estimation in young adults and adolescents of South Indian population using modified Demirjian's method.* Journal of forensic dental sciences: JFDS, 2014. **6**(3): p. 191-6.	India	ca 250	9-20
Monirifard, M., et al., *Radiographic assessment of third molars development and it's relation to dental and chronological age in an Iranian population.* Dental Research Journal, 2015. **12**(1): p. 64-70.	Iran	505	6-17 years
Moze, K. and G. Roberts, *Dental age assessment (DAA) of Afro-Trinidadian children and adolescents. Development of a Reference Dataset (RDS) and comparison with Caucasians resident in London, UK.* Journal of Forensic and Legal Medicine, 2012. **19**(5): p. 272-279.	UK	878	
Nadler, G.L., *Earlier dental maturation: fact or fiction?* Angle Orthodontist, 1998. **68**(6): p. 535-8.		150	8.5-14.5 years
Naik, S.B., et al., *Reliability of third molar development for age estimation by radiographic examination (demirjian's method).* Journal of Clinical and Diagnostic Research, 2014. **8**(5): p. 25-28.	India	100	7-24 years
Ngom, P.I., et al., *[Applicability of standard of Demirjian's method for dental maturation in Senegalese children].* Dakar Medical, 2007. **52**(3): p. 196-203.	Senegal	200	6-14 years

Nik-Hussein, N.N., K.M. Kee, and P. Gan, *Validity of Demirjian and Willems methods for dental age estimation for Malaysian children aged 5-15 years old.* Forensic Science International, 2011. **204**(1): p. 208.e1-6.	Malaysia	991	5-15 years
Nour El Deen, R.E., et al., *Development of the Permanent Dentition and Validity of Demirjian and Goldstein Method for Dental Age Estimation in Sample of Saudi Arabian Children (Qassim Region).* International Journal of Health Sciences, 2016. **10**(1): p. 21-8.	Saudi Arabia	ca 130	4.37 to 13.94 years
Nur BG, Altunsoy M, Akkemik O, Ok E, Evcil MS. Third-molar mineralization and eruption correlated to chronologic age in Turkish children and adolescents. Australian Journal of Forensic Sciences, 2015. 47(3): p. 313-21.	Turkey	1120	7-22 years
Nur, B., et al., *Validity of demirjian and nolla methods for dental age estimation for Northeastern Turkish children aged 5-16 years old.* Medicina Oral, Patologia Oral y Cirugia Bucal, 2012. **17**(5): p. 871-7.	Turkey	673	5-16 years
Nyarady, Z., et al., *Age estimation of children in south-western Hungary using the modified Demirjian method. [Hungarian].* Fogorvosi szemle, 2005. **98**(5): p. 193-198.	Hungary	203	3-18 years
Nykanen, R., et al., *Validity of the Demirjian method for dental age estimation when applied to Norwegian children.* Acta Odontologica Scandinavica, 1998. **56**(4): p. 238-44.	Norway	261	6-12 years
Nystrom, M., et al., *Dental maturity in Finnish children, estimated from the development of seven permanent mandibular teeth.* Acta Odontologica Scandinavica, 1986. **44**(4): p. 193-8.	Finland	248	2-16 years
Nystrom, M., et al., *Dental maturity in Finns and the problem of missing teeth.* Acta Odontologica Scandinavica, 2000. **58**(2): p. 49-56.	Finland	1653	2-25 years
Odeh, R., et al., *Infraocclusion: Dental development and associated dental variations in singletons and twins.* Archives of Oral Biology, 2015. **60**(9): p. 1394-402.	Australia, Finland	1600	8-11 years
Ogodescu, A.E., et al., *Estimation of child's biological age based on tooth development.* Romanian Journal of Legal Medicine, 2011. **19**(2): p. 115-124.	Romania	441	5-15 years
Olze, A., A. Otto, and M. Tsokos, *Influence of retention on the rate of mineralization of third molars. [German].* Rechtsmedizin, 2012. **22**(2): p. 110-114.	Germany	1198	15-40 years
Olze, A., et al., *Age-dependence of secondary dentin apposition in the pulp cavity. Orthopantomogram study. [German].* Rechtsmedizin, 2012. **22**(5): p. 374-378.	Germany	1299	15-40 years
Olze, A., et al., *Comparative study on the chronology of third molar mineralization in a Japanese and a German population.* Legal Medicine, 2003. **5**: p. S256-60.	Japan and Germany	3000	12-26 years
Olze, A., et al., *Forensic age estimation in living subjects: the ethnic factor in wisdom tooth mineralization.* International Journal of Legal Medicine, 2004. **118**(3): p. 170-3.	Germany, Japan, South Africa	3652	12-26 years
Olze, A., et al., *Studies on the chronology of third molar mineralization in a Japanese population.* Legal Medicine, 2004. **6**(2): p. 73-9.	Japan	1615	12-30 years
Orhan, K., et al., *Radiographic evaluation of third molar development in relation to chronological age among Turkish children and youth.* Forensic Science International, 2007. **165**(1): p. 46-	Turkey	1134	4-20 years

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Pathak, H.V., et al., *Orthopantomographic evaluation of canine and first premolar using Demirjian's stages in central India: new approach to forensic age estimation.* Journal of Forensic Sciences, 2012. **57**(4): p. 1082-6.	India	340	5-14 years
Peiris, T.S., G.J. Roberts, and N. Prabhu, *Dental Age Assessment: a comparison of 4- to 24-year-olds in the United Kingdom and an Australian population.* International Journal of Paediatric Dentistry, 2009. **19**(5): p. 367-76.	UK, Australia	154	4-24 years
Pelsmaekers, B., et al., *The genetic contribution to dental maturation.* Journal of Dental Research, 1997. **76**(7): p. 1337-40.	Belgium	116	8-11 years
Perinetti, G., et al., *Diagnostic performance of dental maturity for identification of skeletal maturation phase.* European Journal of Orthodontics, 2012. **34**(4): p. 487-92.	Italy	354	6-17 years
Perinetti, G., et al., *Eruption of the permanent maxillary canines in relation to mandibular second molar maturity.* Angle Orthodontist, 2013. **83**(4): p. 578-83.	Italy	106	9-14 years
Perinetti, G., R. Di Lenarda, and L. Contardo, *Diagnostic performance of combined canine and second molar maturity for identification of growth phase.* Progress in Orthodontics, 2013. **14**: p. 1.	Italy	300	6-17 years
Pinchi V, De Luca F, Focardi M, Pradella F, Vitale G, Ricciardi F, et al. Combining dental and skeletal evidence in age classification: Pilot study in a sample of Italian sub-adults. Legal Medicine. 2016. 20: p. 75-9.	Italian	274	6-17 years
Prabhakar, A.R., A.K. Panda, and O.S. Raju, *Applicability of Demirjian's method of age assessment in children of Davangere.* Journal of the Indian Society of Pedodontics & Preventive Dentistry, 2002. **20**(2): p. 54-62.	India	151	6-15 years
Priyadharshini, K.I., et al., *Age estimation using development of third molars in South Indian population: A radiological study.* Journal of International Society of Preventive & Community Dentistry, 2015. **5**: p. S32-8.	India	848	14-30 years
Qing M, Qiu L, Gao Z, Bhandari K. The chronological age estimation of third molar mineralization of Han population in southwestern China. Journal of forensic and legal medicine. 2014. 24: p. 24-7.	China	2192	8-25 years
Qudeimat, M.A. and F. Behbehani, *Dental age assessment for Kuwaiti children using Demirjian's method.* Annals of Human Biology, 2009. **36**(6): p. 695-704.	Kuwait	509	3-14 years
Rai, B., J. Kaur, and H. Jafarzadeh, *Dental age estimation from the developmental stage of the third molars in Iranian population.* Journal of Forensic and Legal Medicine, 2010. **17**(6): p. 309-311.	Iran	1200	10-27 years
Rai, B., J. Kaur, and S.C. Anand, *Mandibular third molar development staging to chronologic age and sex in north Indian children and young adults.* Journal of Forensic Odonto-Stomatology, 2009. **27**(2): p. 45-9.	India	250	7-26 years
Roberts, G.J., et al., *Dental age assessment (DAA): a simple method for children and emerging adults.* British Dental Journal, 2008. **204**(4): p. E7; discussion 192-3.	UK	1547	1-26 years
Rozylo-Kalinowska, I., A. Kolasa-Raczka, and P. Kalinowski, *Dental age in patients with impacted maxillary canines related*	Poland	116	12-16 years

to the position of the impacted teeth. European Journal of Orthodontics, 2011. **33**(5): p. 492-7.			
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Rozylo-Kalinowska, I., E. Kiworkowa-Raczkowska, and P. Kalinowski, *Dental age in Central Poland.* Forensic Science International, 2008. **174**(2): p. 207-16.	Poland	994	6-16 years
Santoro V, Roca R, De Donno A, Fiandaca C, Pinto G, Tafuri S, et al. Applicability of Greulich and Pyle and Demirijan aging methods to a sample of Italian population. Forensic Science International, 2012. 221(1): p. 153 e1-5.	Italy	532	7-15 years
Sarkar, S., S. Kailasam, and P. Mahesh Kumar, *Accuracy of estimation of dental age in comparison with chronological age in Indian population-A comparative analysis of two formulas.* Journal of Forensic and Legal Medicine, 2013. **20**(4): p. 230-233.	India	100	5-24 years
Sasso, A., et al., *Secular trend in the development of permanent teeth in a population of Istria and the littoral region of Croatia.* Journal of Forensic Sciences, 2013. **58**(3): p. 673-7.	Croatia	1000	6-16 years
Sasso, A., et al., *Secular trend of earlier onset and decelerated development of third molars: evidence from Croatia.* Forensic Science International, 2015. **249**: p. 202-6.	Croatia	1103	6-18 years
Scheurer, E., et al., *Validation of reference data on wisdom tooth mineralization and eruption for forensic age estimation in living persons.* International Journal of Legal Medicine, 2011. **125**(5): p. 707-15.	Central European	307	17-18 years
Shi, G.F., et al., *Application of Demirjian's method for chronological age estimation in teenagers of Shanghai Han population. [Chinese].* Journal of Forensic Medicine, 2009. **25**(3): p. 168-171.	China	501	11-20 years
Sisman, Y., et al., *Third-molar development in relation to chronologic age in Turkish children and young adults.* Angle Orthodontist, 2007. **77**(6): p. 1040-5.	Turkish	900	8-25 years
Soares, C.B., et al., *Evaluation of third molar development in the estimation of chronological age.* Forensic Science International, 2015. **254**: p. 13-7.	Brazil	11396	6-22 years
Solari, A.C. and K. Abramovitch, *The accuracy and precision of third molar development as an indicator of chronological age in Hispanics.* Journal of Forensic Sciences, 2002. **47**(3): p. 531-5.	USA	679	14-25 years
Srkoc, T., et al., *Association between Dental and Skeletal Maturation Stages in Croatian Subjects.* Acta Clinica Croatica, 2015. **54**(4): p. 445-52.	Croatia	295	7-18 years
Streckbein, P., et al., *Estimation of legal age using calcification stages of third molars in living individuals.* Science and Justice, 2014. **54**(6): p. 447-450.	Germany	2360	15-23 years
Sukhia, R.H. and M. Fida, *Correlation among chronologic age, skeletal maturity, and dental age.* World Journal of Orthodontics, 2010. **11**(4): p. e78-84.	Pakistan	380	7-17 years
Sukhia, R.H., M. Fida, and S.I. Azam, *Dental age table for a sample of Pakistani children.* European Journal of Orthodon-	Pakistan	882	7-14 years

tics, 2012. **34**(1): p. 77-82.			
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Tangmose S, Thevissen P, Lynnerup N, Willems G, Boldsen J. Age estimation in the living: Transition analysis on developing third molars. Forensic Science International, 2015. 257: p. 512.e1-7.	Korea	854	15-25 years
Tao, J., et al., *Accuracy of age estimation from orthopantomograph using Demirjian's method. [Chinese].* Fa yi xue za zhi, 2007. **23**(4): p. 258-260.	China	828	11-19 years
Teivens, A. and H. Mornstad, *A comparison between dental maturity rate in the Swedish and Korean populations using a modified Demirjian method.* Journal of Forensic Odonto-Stomatology, 2001. **19**(2): p. 31-5.	Sweden, Korea	795	3-17 years
Teivens, A. and H. Mornstad, *A modification of the Demirjian method for age estimation in children.* Journal of Forensic Odonto-Stomatology, 2001. **19**(2): p. 26-30.	Sweden	485	2.6-17.2 years
TeMoananui, R., et al., *Estimating age in Maori, Pacific Island, and European children from New Zealand.* Journal of Forensic Sciences, 2008. **53**(2): p. 401-4.	New Zealand	1383	3-14 years
Thorson, J. and U. Hagg, *The accuracy and precision of the third mandibular molar as an indicator of chronological age.* Swedish Dental Journal, 1991. **15**(1): p. 15-22.	Sweden	372	14-24 years
Toth, Z.O., O. Udvar, and J. Angyal, *[Chronological age estimation based on dental panoramic radiography].* Fogorvosi Szemle, 2014. **107**(3): p. 93-8.	Hungary	199	3-20 years
Tunc, E.S. and A.E. Koyuturk, *Dental age assessment using Demirjian's method on northern Turkish children.* Forensic Science International, 2008. **175**(1): p. 23-6.	Turkey	900	4-12 years
Urzel, V. and J. Bruzek, *Validity of the standards of Demirjian and Goldstein (1976) and of Chaillet and Demirjian (2004) for children age estimation in South West France. [French].* Revue de Medecine Legale, 2011. **2**(3): p. 108-116.	France	911	5-18 years
Uys, A., I. Fabris-Rotelli, and H. Bernitz, *Estimating age in black South African children.* SADJ : journal of the South African Dental Association = tydskrif van die Suid-Afrikaanse Tandheelkundige Vereniging, 2014. **69**(2): p. 54-58, 60-61.	South Africa	838	6-18 years
Valizadeh S, Eil N, Ehsani S, Bakhshandeh H. Correlation between dental and cervical vertebral maturation in Iranian females. Iranian Journal of Radiology, 2012. 10(1): p.1-7.	Iran	400	8-14 years
Vardimon, A.D., et al., *Incremental growth of the maxillary tuberosity from 6 to 20 years-A cross-sectional study.* Archives of Oral Biology, 2010. **55**(9): p. 655-62.	Unclear	189	16-20 years
Vemareddy, S., et al., *Evaluation of third molar as an indicator of age estimation in Chennai population.* Indian Journal of Forensic Medicine and Toxicology, 2015. **9**(2): p. 126-130.	India	200	
Vucic, S., et al., *Secular trend of dental development in Dutch children.* American Journal of Physical Anthropology, 2014. **155**(1): p. 91-8.	Netherland	753	2-16 years
Weddell, L.S. and J.K. Hartsfield, Jr., *Dental maturity of Caucasian children in the Indianapolis area.* Pediatric Dentistry, 2011.	USA	257	5-17 years

33(3): p. 221-7.			
Willems, G., et al., *Dental age estimation in Belgian children: Demirjian's technique revisited.* Journal of Forensic Sciences, 2001. **46**(4): p. 893-5.	Belgium	2523	1-18 years
Willems, G., et al., *Willems II. Non-gender-specific dental maturity scores.* Forensic Science International, 2010. **201**(1): p. 84-5.	Belgium	2116	3-16 years
Ye, X., et al., *Dental age assessment in 7-14-year-old Chinese children: comparison of Demirjian and Willems methods.* Forensic Science International, 2014. **244**: p. 36-41.	China	410	7-14 years
Zhai, Y., et al., *Dental age assessment in a northern Chinese population.* Journal of Forensic and Legal Medicine, 2016. **38**: p. 43-49.	China	1004	11-18 years
Zhao, J., L. Ding, and R. Li, *[Study of dental maturity in children aged 3-16 years in Chengdu].* Hua-Hsi i Ko Ta Hsueh Hsueh Pao [Journal of West China University of Medical Sciences], 1990. **21**(3): p. 242-6.	China	903	3-16 years

Appendix 4: Relevant datasets using other index tests than Demirjian's stages to classify dental age/dental maturation on orthopantomograms

In addition to the studies with relevant datasets using Demirjian's stages as an index test, we identified a further 150 studies that had collected data both on dental age/dental maturation based on other classification systems than Demirjian's stages and had data on chronological age. The population criteria appear fulfilled, i.e. data for > 50 healthy children in age range 10-26 years. Some of these studies were analysed with regard to other objectives than ours. We have gathered information about these studies because they may represent potential relevant datasets for further analyses.

Reference	Scoring method(s)	Country	No. Of partici-pants	Age range
Acharya, A.B., B. Bhowmik, and V.G. Naikmasur, *Accuracy of identifying juvenile/adult status from third molar development using prediction probabilities derived from logistic regression analysis.* Journal of Forensic Sciences, 2014. **59**(3): p. 665-70.	Köhler's grading	India	268	14-23 years
AlQahtani, S.J., M.P. Hector, and H.M. Liversidge, *Accuracy of dental age estimation charts: Schour and Massler, Ubelaker and the London Atlas.* American Journal of Physical Anthropology, 2014. **154**(1): p. 70-8.	Schour and Massler, Ubelaker, and the London Atlas	UK	1429	0-23 years
AlQahtani, S.J., M.P. Hector, and H.M. Liversidge, *Brief communication: The London atlas of human tooth development and eruption.* American Journal of Physical Anthropology, 2010. **142**(3): p. 481-90.	London atlas	UK	528	2-23 years
Alshihri, A.M., E. Kruger, and M. Tennant, *Dental age assessment of Western Saudi children and adolescents.* The Saudi Dental Journal, 2015. **27**(3): p. 131-6.	London atlas	Saudi Arabia	252	2-20 years
Alshihri, A.M., E. Kruger, and M. Tennant, *Western Saudi adolescent age estimation utilising third molar development.* European journal of dentistry, 2014. **8**(3): p. 296-301.	London Atlas	Saudi Arabia	252	2-20 years
Anderson DL, Thompson GW, Popovich F. Interrelationships of dental maturity, skeletal maturity, height and weight from age 4 to 14 years. Growth, 1975.39(4): p. 453-62.	Moorrees	Denmark	232	4 to 14
Anderson, D.L., G.W. Thompson, and F. Popovich, *Age of attainment of mineralization stages of the permanent dentition.* Journal of Forensic Sciences, 1976. **21**(1): p. 191-200.	Moorrees	Canada	132	3-18 years
Bagherpour, A., et al., *Dental age assessment of young Iranian adults using third molars: A multivariate regression study.* Journal of Forensic and Legal Medicine, 2012. **19**(7): p. 407-412.	Gleiser and Hunt, modified by Köhler	Iran	1274	15-22 years
Bhat VJ, Kamath GP. Age estimation from root de-	Kullmann	India	735	15-25 years

velopment of mandibular third molars in comparison with skeletal age of wrist joint. American Journal of Forensic Medicine and Pathology. 2007. 28(3): p. 238-41.				
Bhat, V.J. and G. Kamath, *Age estimation from the root development of mandibular third molars.* Medico-Legal Update, 2004. **4**(4): p. 127-130.	Kullman	India	735	15-25 years
Bhowmik, B., A.B. Acharya, and V.G. Naikmasur, *The usefulness of Belgian formulae in third molar-based age assessment of Indians.* Forensic Science International, 2013. **226**(1): p. 300.e1-5.	Belgian formula	India	268	14-23 years
Bolanos, M.V., et al., *Approaches to chronological age assessment based on dental calcification.* Forensic Science International, 2000. **110**(2): p. 97-106.	Nolla	Spain	525	3-15 years
Bolanos, M.V., et al., *Radiographic evaluation of third molar development in Spanish children and young people.* Forensic Science International, 2003. **133**(3): p. 212-9.	Nolla	Spain	786	2-20 years
Bosmans, N., et al., *The application of Kvaal's dental age calculation technique on panoramic dental radiographs.* Forensic Science International, 2005. **153**(2): p. 208-12.	Kvaal and Solheim		197	19-75 years
Brkic, H., et al., *The chronology of third molar eruption in the Croatian population.* Collegium Antropologicum, 2011. **35**(2): p. 353-7.	Unclear staging system	Croatia	1249	10-25 years
Butti, A.C., et al., *Haavikko's method to assess dental age in Italian children.* European Journal of Orthodontics, 2009. **31**(2): p. 150-5.	Haavikko	Italy	500	4-15 years
Caldas, I.M., et al., *Chronological course of third molar eruption in a Portuguese population.* International Journal of Legal Medicine, 2012. **126**(1): p. 107-12.	Olze	Portugal	522	6-22 years
Cameriere R, De Luca S, Biagi R, Cingolani M, Farronato G, Ferrante L. Accuracy of three age estimation methods in children by measurements of developing teeth and carpals and epiphyses of the ulna and radius. Journal of Forensic Sciences. 2012. 57(5): p. 1263-70.	Cameriere's method with Haaviko's categories	Italy	288	5-15 years
Cameriere R, De Luca S, Biagi R, Cingolani M, Farronato G, Ferrante L. Accuracy of three age estimation methods in children by measurements of developing teeth and carpals and epiphyses of the ulna and radius. Journal of Forensic Sciences, 2012. 57(5): p. 1263-70.	Unclear staging system	Italy	288	5-15 years
Cameriere R, De Luca S, Cingolani M, Ferrante L. Measurements of developing teeth, and carpals and epiphyses of the ulna and radius for assessing new cut-offs at the age thresholds of 10, 11, 12, 13 and 14 years. Journal of Forensic & Legal Medicine, 2015. 34: p. 50-4.	Cameriere formula for canines	Italy	291	5-15 years
Cameriere R, Ferrante L, Ermenc B, Mirtella D, Strus K. Age estimation using carpals: study of a Slovenian	Cameriere	Slovenia	158	6 -16 years

sample to test Cameriere's method. Forensic Science International, 2008. 174(2):p. 178-81.				
Cameriere, R., et al., *Accuracy of age estimation in children using radiograph of developing teeth.* Forensic Science International, 2008. **176**(2): p. 173-7.	Cameriere, Demirjian and Willems	Italy, Spain and Croatia	756	5-15 years
Cameriere, R., et al., *Adult or not? Accuracy of Cameriere's cut-off value for third molar in assessing 18 years of age for legal purposes.* Minerva Stomatologica, 2014. **63**(9): p. 283-94.	Cameriere	Italy, Spain and Croatia	287	13-22 years
Cameriere, R., et al., *Age estimation by pulp/tooth ratio in lateral and central incisors by peri-apical X-ray.* Journal of Forensic and Legal Medicine, 2013. **20**(5): p. 530-536.	Cameriere	Spain	606	18-75 years
Cameriere, R., et al., *Age estimation in children by measurement of open apices in teeth with Bayesian calibration approach.* Forensic Science International, 2016. **258**: p. 50-4.	Cameriere's method with Bayesian calibration	Italy	2630	4-17 years
Cameriere, R., et al., *Age estimation in children by measurement of open apices in teeth: a European formula.* International Journal of Legal Medicine, 2007. **121**(6): p. 449-53.	Cameriere's third molar index	Albania	286	15-22 years
Cameriere, R., et al., *Assessment of legal adult age of 18 by measurement of open apices of the third molars: Study on the Albanian sample.* Forensic Science International, 2014. **245**: p. 205.e1-205.e5.	Cameriere	Albania	286	15-22 years
Cameriere, R., et al., *The measurement of open apices of teeth to test chronological age of over 14-year olds in living subjects.* Forensic Science International, 2008. **174**(2): p. 217-21.	Cameriere's	Italy, Croatia and Slovenia	447	12-16 years
Cameriere, R., L. Ferrante, and M. Cingolani, *Age estimation in children by measurement of open apices in teeth.* International Journal of Legal Medicine, 2006. **120**(1): p. 49-52.	open apices in teeth	Italy	455	5-15 years
Cameriere, R., L. Ferrante, and M. Cingolani, *Precision and reliability of pulp/tooth area ratio (RA) of second molar as indicator of adult age.[Erratum appears in J Forensic Sci. 2005 Mar;50(2):486].* Journal of Forensic Sciences, 2004. **49**(6): p. 1319-23.	Unclear scoring method, M2 and M3	Italy	312	14-24 years
Cardoso Silva, C., et al., *Primary molar infraocclusion: frequency, magnitude, root resorption and premolar agenesis in a Spanish sample.* European journal of paediatric dentistry: official journal of European Academy of Paediatric Dentistry, 2014. **15**(3): p. 258-264.	Bjerklin and Bennett method and Demirjian	Spain	654	3-13 years
Celikoglu, M., et al., *Dental age assessment in orthodontic patients with and without skeletal malocclusions.* Orthodontics & Craniofacial Research, 2011. **14**(2): p. 58-62.	Unclear staging system	Turkey	525	9-15 years
Chen, J., et al., *Correlation between dental maturity and cervical vertebral maturity.* Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology and Endo-	tooth calcification stage	China	302	8-16 years

dontology, 2010. **110**(6): p. 777-783.				
Clow, I.M., *A radiographic survey of third molar development: a comparison.* British Journal of Orthodontics, 1984. **11**(1): p. 9-15.	Gravely's classification	Scotland	1154	6-15 years
Corral, C., et al., *Chronological versus dental age in subjects from 5 to 19 years: A comparative study with forensic implications.* Colombia Medica, 2010. **41**(3): p. 215-223.	Multiple scoring methods	Colombia	196	5-19 years
Coutinho S, Buschang PH, Miranda F. Relationships between mandibular canine calcification stages and skeletal maturity. American Journal of Orthodontics & Dentofacial Orthopedics, 1993. 104(3): p. 262-8.	Cameriere formula for canines	USA	415	7 -16 years
Cugati, N., et al., *Dental age estimation of growing children by measurement of open apices: A Malaysian formula.* Journal of forensic dental sciences: JFDS, 2015. **7**(3): p. 227-31.	Cameriere	Malaysia	421	5-16 years
Daito, M., et al., *Calcification of the permanent first molars observed in panoramic radiographs.* Journal of Osaka Dental University, 1989. **23**(1): p. 45-55.	Moorrees	Japan	1167	2-15 years
De Luca, S., et al., *Accuracy of Cameriere's cut-off value for third molar in assessing 18 years of age.* Forensic Science International, 2014. **235**: p. 102.e1-6.	Cameriere's	Italy	397	13-22 years
De Luca, S., et al., *Accuracy of cut-off value by measurement of third molar index: Study of a Colombian sample.* Forensic Science International, 2016. **261**: p. 160.e1-160.e5.	Cameriere	Colombia	288	13-22 years
De Luca, S., et al., *Age estimation in children by measurement of open apices in tooth roots: Study of a Mexican sample.* Forensic Science International, 2012. **221**(1): p. 155.e1-7.	Cameriere's European	Mexico	502	5-15 years
De Luca, S., et al., *Third molar development by measurements of open apices in an Italian sample of living subjects.* Journal of Forensic and Legal Medicine, 2016. **38**: p. 36-42.	Cameriere	Italy	975	9-22 years
de Moraes, M.E., et al., *Age assessment based on dental calcification in individuals with Down syndrome.* Research in Developmental Disabilities, 2013. **34**(11): p. 4274-9.	Nolla	Brazil	191	5-16 years
Deitos, A.R., et al., *Age estimation among Brazilians: Younger or older than 18?* Journal of Forensic and Legal Medicine, 2015. **33**: p. 111-115.	Cameriere	Brazil	444	14-22 years
Domken, O., et al., *[How I investigate...the age of adolescents using panoramic radiography].* Revue Medicale de Liege, 1998. **53**(10): p. 633-7.		Belgium	285	15-21 years
Drusini, A.G., O. Toso, and C. Ranzato, *The coronal pulp cavity index: a biomarker for age determination in human adults.* American Journal of Physical Anthropology, 1997. **103**(3): p. 353-63.	Unclear staging system	Italy	433	9-76 years
Elamin, F. and H.M. Liversidge, *Malnutrition Has No Effect on the Timing of Human Tooth Formation.* PLoS ONE, 2013. **8**.	Moorees	Sudan	2115	2-22 years
El-Bakary, A.A., S.M. Hammad, and F. Mohammed,	Cameriere,	Egypt	286	5-16 years

Dental age estimation in egyptian children, comparison between two methods. Journal of Forensic and Legal Medicine, 2010. **17**(7): p. 363-367.	Willems			
Engstrom C, Engstrom H, Sagne S. Lower third molar development in relation to skeletal maturity and chronological age. Angle Orthodontist, 1983. 53(2): p. 97-106.	Unclear staging system	Sweden	221	8-21 years
Fahmy, M.S., *The estimation of age of Arabs from their dentitions. An orthopantomographic study of the permanent dentition of different Arab nationalities.* Journal of the Kuwait Medical Association, 1974. **8**(3): p. 145-162.		Kuwait, Palestina, Jordan, Saudi Aravia, Oman, Yemen, Iraq, Egypt, Leban, Syrian	3500	3-65 years
Fernandes, M.M., et al., *Age estimation by measurements of developing teeth: accuracy of Cameriere's method on a Brazilian sample.* Journal of Forensic Sciences, 2011. **56**(6): p. 1616-9.	Cameriere	Brazil	160	5-15 years
Fulton, A.J. and H.M. Liversidge, *A radiographic study of estimating age by deciduous mandibular canine and molar root resorption.* Annals of Anatomy, 2016. **203**: p. 33-7.	Moorrees, Fanning, O'Meara and Knott	UK	940	3-16 years
Galic, I., et al., *Accuracy of Cameriere, Haavikko, and Willems radiographic methods on age estimation on Bosnian-Herzegovian children age groups 6-13.* International Journal of Legal Medicine, 2011. **125**(2): p. 315-21.	Cameriere, Haavikko, and Willems	Bosnia Herzegovina	1089	6-13 years
Galic, I., et al., *Cameriere's third molar maturity index in assessing age of majority.* Forensic Science International, 2015. **252**: p. 191.e1-5.	Cameriere	Croatia	1336	14-23 years
Galic, I., et al., *Dental age estimation on Bosnian-Herzegovinian children aged 6-14 years: Evaluation of Chaillet's international maturity standards.* Journal of Forensic and Legal Medicine, 2013. **20**(1): p. 40-45.	Chaillet's	Bosnia Herzegovinia	1772	6-15 years
Gulsahi, A., et al., *The reliability of Cameriere's method in Turkish children: a preliminary report.* Forensic Science International, 2015. **249**: p. 319.e1-5.	Calmeriere	Turkey	573	8-15 years
Gunst, K., et al., *Third molar root development in relation to chronological age: a large sample sized retrospective study.* Forensic Science International, 2003. **136**(1): p. 52-7.	Gleiser & Hunt	Belgium	2513	16-23 years
Guo, Y.C., et al., *Age estimation in northern Chinese children by measurement of open apices in tooth roots.* International Journal of Legal Medicine, 2015. **129**(1): p. 179-86.	Cameriere, Chinese formula	China	785	5-15 years
Guo, Y.C., et al., *Studies of the chronological course of third molars eruption in a northern Chinese population.* Archives of Oral Biology, 2014. **59**(9): p. 906-11.	Olze	China	1135	11-26 years

Han, B., et al., *A study on low mandibula dental age of Chinese Han nationality adolescents age from 6 to 15 years old in Anyang of Henan province.* Chinese Journal of Forensic Medicine, 2011. **26**(3): p. 176-179.	Unnamed new meth-od	Chinese	1575	6-15 years
Harris, E.F., *Mineralization of the mandibular third molar: a study of American blacks and whites.* American Journal of Physical Anthropology, 2007. **132**(1): p. 98-109.	Moorrees	USA	4010	3-25 years
Harris, M.J. and C.J. Nortje, *The mesial root of the third mandibular molar. A possible indicator of age.* Journal of Forensic Odonto-Stomatology, 1984. **2**(2): p. 39-43.	Nortje	South Africa	407	15-21 years
Holtgrave, E.A., R. Kretschmer, and R. Muller, *Acceleration in dental development: fact or fiction.* European Journal of Orthodontics, 1997. **19**(6): p. 703-10.	Nolla	Europe	1038	3-18 years
Hongwei S, Jingtao J, Cameron JM. Age determination of the molars. Medicine, Science and the Law, 1991. 31(1):p. 65-8.	unnamed new meth-od	China	495	13- 60+ years
Karadayi, B., et al., *Radiological age estimation: based on third molar mineralization and eruption in Turkish children and young adults.* International Journal of Legal Medicine, 2012. **126**(6): p. 933-42.	Nolla	Turkey	744	8-22 years
Karkhanis, S., P. Mack, and D. Franklin, *Dental age estimation standards for a Western Australian population.* Forensic Science International, 2015. **257**: p. 509.e1-9.	Moorrees Bengston	Australia	392	4-25 years
Kohler, S., et al., *The development of the third molar as criterion for age determination. [German].* Annals of Anatomy, 1994. **176**(4): p. 339-345.	Gleiser & Hunt	Germany	938	15-25 years
Kullman, L., et al., *Computerized measurements of the lower third molar related to chronologic age in young adults.* Acta Odontologica Scandinavica, 1995. **53**(4): p. 211-6.	Kullman	Sweden	391	
Kullman, L., G. Johanson, and L. Akesson, *Root development of the lower third molar and its relation to chronological age.* Swedish Dental Journal, 1992. **16**(4): p. 161-7.	Kullman	Sweden	677	11-25 year
Kumaresan R, Cugati N, Chandrasekaran B, Karthikeyan P. Reliability and validity of five radiographic dental-age estimation methods in a population of Malaysian children. Journal of Investigative & Clinical Dentistry, 2016. 7(1):p. 102-9.	multiple methods	Thailand	426	5-15 years
Kurita, L.M., et al., *Dental maturity as an indicator of chronological age: radiographic assessment of dental age in a Brazilian population.* Journal of Applied Oral Science, 2007. **15**(2): p. 99-104.	Nolla	Brazil	360	7-15 years
Lapter, V., et al., *[Identification of dental age in twins].* Acta Stomatologica Croatica, 1984. **18**(2): p. 81-93.	Nolla	Croatia	200	5-16 years
Legovic, M., et al., *The reliability of chronological age determination by means of mandibular third*	Nolla	Croatia	979	5-15 years

molar development in subjects in Croatia. Journal of Forensic Sciences, 2010. **55**(1): p. 14-8.				
Leinonen, A., B. Wasz-Hockert, and P. Vuorinen, *Usefulness of the dental age obtained by orthopan-tomography as an indicator of the physical age.* Proceedings of the Finnish Dental Society, 1972. **68**(5): p. 235-42.	Haavikko	Finland	61	
Liversidge, H.M. and P.H. Marsden, *Estimating age and the likelihood of having attained 18 years of age using mandibular third molars.* British Dental Journal, 2010. **209**(8): p. E13.	Moorrees, adapted by Liversidge	UK	300	11-25
Liversidge, H.M., *Controversies in age estimation from developing teeth.* Annals of Human Biology, 2015. **42**(4): p. 397-406.	multiple methods	UK	946	3-16 years
Liversidge, H.M., F. Lyons, and M.P. Hector, *The accuracy of three methods of age estimation using radiographic measurements of developing teeth.* Forensic Science International, 2003. **131**(1): p. 22-9.	Mornstad Liversidge Molleston Carels	UK	145	8-13 years
Liversidge, H.M., *Permanent tooth formation as a method of estimating age.* Frontiers of oral biology, 2009. **13**: p. 153-7.	Moorrees	UK	1050	2-22 years
Liversidge, H.M., *Similarity in dental maturation in two ethnic groups of London children.* Annals of Human Biology, 2011. **38**(6): p. 702-715.	Moorrees	UK	1050	2-22 years
Lu, M., et al., *Dental calcification of 15-22 years old male in Dongguan city and its forensic significance. [Chinese].* Chinese Journal of Forensic Medicine, 2013. **28**(4): p. 310-313.	Tian Xumei	Chinese	310	15-22 years
Maki, K., et al., *The impact of race on tooth formation.* ASDC journal of dentistry for children, 1999. **66**(5): p. 353-356, 294-295.	Kullmann	USA	650	6-12 years
Maled, V., et al., *The chronology of third molar root mineralization in south Indian population.* Medicine, Science & the Law, 2014. **54**(1): p. 28-34.	Kullman	India	192	13-25 years
Marques, M.R., M.D.L. Pereira, and I.M. Caldas, *Forensic age estimation using the eruption of the second permanent mandibular molar: Determining age over 14 years-old.* Australian Journal of Forensic Sciences, 2015. **47**(3): p. 306-312.	Olze	Portugal	200	3-15 years
Merwin, D.R. and E.F. Harris, *Sibling similarities in the tempo of human tooth mineralization.* Archives of Oral Biology, 1998. **43**(3): p. 205-10.	Moorrees	USA	382	4-16 years
Meshram AH, Dode CR, Lanjewar DN. Estimation of age of Indian adolescents by radiographic study of mandibular third molar. Indian Journal of Forensic Medicine and Toxicology, 2013. 7(1):246-50.	Bhat and Kamath's staging	India	100	15-20 years
Mesotten, K., et al., *Chronological age determination based on the root development of a single third molar: a retrospective study based on 2513 OPGs.* Journal of Forensic Odonto-Stomatology, 2003. **21**(2): p. 31-5.	Gleiser & Hunt	Belgium	2513	15-22 years
Mesotten, K., et al., *Dental age estimation and third*	Chaillet	Belgium	1175	16-22 years

molars: a preliminary study. Forensic Science International, 2002. **129**(2): p. 110-5.				
Miloglu, O., et al., *Is the assessment of dental age by the Nolla method valid for eastern Turkish children?* Journal of Forensic Sciences, 2011. **56**(4): p. 1025-8.	Nolla	Turkey	600	9-18 years
Mohammed, R.B., et al., *Accuracy of Demirjian's 8 teeth method for age prediction in South Indian children: A comparative study.* Contemporary Clinical Dentistry, 2015. **6**(1): p. 5-11.	Haavikko	India	660	9-20 years
Mohammed, R.B., et al., *Dental age estimation using Willems method: A digital orthopantomographic study.* Contemporary Clinical Dentistry, 2014. **5**(3): p. 371-6.	Willems	India	332	6-16 years
Mohd Yusof, M.Y.P., et al., *Application of third molar development and eruption models in estimating dental age in Malay sub-adults.* Journal of Forensic and Legal Medicine, 2015. **34**: p. 40-44.	Gleiser & Hunt, Olze	Malaysia	705	14-24 years
Mornstad, H., M. Reventlid, and A. Teivens, *The validity of four methods for age determination by teeth in Swedish children: a multicentre study.* Swedish Dental Journal, 1995. **19**(4): p. 121-30.	Several methods	Sweden	197	5-12 years
Murthy KK, Srinivas CN, Lakshmi V, Kumar CV, Krishnaveni M. Assessment of skeletal and dental maturity levels for a given chronological age among Indian children. Journal of Contemporary Dental Practice [Electronic Resource], 2012. 13(3): p. 310-5.	Nolla	India	260	3-15 years
Navarro, J., et al., *Dental anomaly pattern (DAP): agenesis of mandibular second premolar, distal angulation of its antimere and delayed tooth formation.* Angle Orthodontist, 2014. **84**(1): p. 24-9.		Not specified	82	8-15 years
Olze, A., et al., *Age-dependence of secondary dentin apposition in the pulp cavity. Orthopantomogram study. [German].* Rechtsmedizin, 2012. **22**(5): p. 374-378.	Dentin apposition in the pulp cavity	Germany	1299	15-40 years
Olze, A., et al., *Application of a modified stage classification in evaluating wisdom tooth eruption in a German population. [German].* Archiv fur Kriminologie, 2012. **229**(5): p. 145-153.	Olze	Germany	606	
Olze, A., et al., *Assessment of the radiographic visibility of the periodontal ligament in the lower third molars for the purpose of forensic age estimation in living individuals.* International Journal of Legal Medicine, 2010. **124**(5): p. 445-8.	Visibility of the periodontal ligament of M3	Germany	1198	15-40 years
Olze, A., et al., *Cementum apposition as a criterion of dental age estimation. [German].* Rechtsmedizin, 2012. **22**(2): p. 106-109.	Cementum apposition	Germany	1299	15-40 years
Olze, A., et al., *Comparative study on the effect of ethnicity on wisdom tooth eruption.* International Journal of Legal Medicine, 2007. **121**(6): p. 445-8.	Eruption of M3	Germany, Japan, South Africa	2482	12-26 years
Olze, A., et al., *Evaluation of the radiographic visibility of the root pulp in the lower third molars for the purpose of forensic age estimation in living individuals.* International Journal of Legal Medicine, 2010.	visibility of the periodontal ligament of	Germany	1198	15-40 years

124(3): p. 183-6.	M3			
Olze, A., et al., *Evaluation of third molar eruption: Comparison of two stage classifications. [German].* Rechtsmedizin, 2012. **22**(6): p. 451-455.	Olze	Germany	216	15-25 years
Olze, A., et al., *Radiologically determined DMF index variations for forensic age estimation of young adults. [German].* Archiv fur Kriminologie, 2004. **214**(3): p. 103-111.	DMF index	Germany	650	18-30 years
Olze, A., et al., *Studies of the chronological course of wisdom tooth eruption in a Black African population.* Journal of Forensic Sciences, 2007. **52**(5): p. 1161-3.	Erruption of M3	South African	516	12-26 years
Olze, A., et al., *Studies of the chronological course of wisdom tooth eruption in a German population.* Journal of Forensic and Legal Medicine, 2008. **15**(7): p. 426-429.	Erruption of M3	Germany	666	12-26 years
Olze, A., et al., *Studies of the chronological course of wisdom tooth eruption in a Japanese population.* Forensic Science International, 2008. **174**(2): p. 203-6.	Erruption of M3	Japan	1300	14-26 years
Olze, A., et al., *Studies on the chronology of third molar mineralization in a German population. [German].* Rechtsmedizin, 2003. **13**(1): p. 5-10.	Olze		1434	12-26 years
Onat Altan, H., et al., *The applicability of Willems' method for age estimation in southern Turkish children: A preliminary study.* Journal of Forensic and Legal Medicine, 2016. **38**: p. 24-27.	Williems	Turkey	756	5-15 years
Pathak, S.K., et al., *A study of eruption of third molar in relation to estimation of age in people of 13 to 25 years age group.* Journal of Forensic Medicine and Toxicology, 1999. **16**(1): p. 17-19.	Nolla	India	174	13-25 years
Patnana, A.K., R.S. Vabbalareddy, and V.V. NR, *Evaluating the reliability of three different dental age estimation methods in visakhapatnam children.* Jaypees International Journal of Clinical Pediatric Dentistry, 2014. **7**(3): p. 186-91.	multiple methods	India	102	6-14 years
Pechnikova, M., et al., *Twins and the paradox of dental-age estimations: a caution for researchers and clinicians.* Homo: internationale Zeitschrift fur die vergleichende Forschung am Menschen, 2014. **65**(4): p. 330-337.	multiple methods	Kosovo	128	6-13 years
Perez-Mongiovi, D., A. Teixeira, and I.M. Caldas, *The radiographic visibility of the root pulp of the third lower molar as an age marker.* Forensic Science, Medicine & Pathology, 2015. **11**(3): p. 339-44.	Olze	Portugal	487	17-30 years
Phillips, V.M. and T.J. van Wyk Kotze, *Dental age related tables for children of various ethnic groups in South Africa.* Journal of Forensic Odonto-Stomatology, 2009. **27**(2): p. 29-44.	Moorress	South Africa	1470	3-17 years
Phillips, V.M. and T.J. van Wyk Kotze, *Testing standard methods of dental age estimation by Moorrees, Fanning and Hunt and Demirjian, Goldstein and Tanner on three South African children samples.* Journal of Forensic Odonto-Stomatology, 2009.	multiple methods	South Africa	914	3-16 years

27(2): p. 20-8.				
Pinchi, V., et al., *Comparison of the applicability of four odontological methods for age estimation of the 14 years legal threshold in a sample of Italian adolescents.* Journal of Forensic Odonto-Stomatology, 2012. **30**(2): p. 17-25.	multiple methods	Italy	501	11-16 years
Pinchi, V., et al., *Comparison of the diagnostic accuracy, sensitivity and specificity of four odontological methods for age evaluation in Italian children at the age threshold of 14 years using ROC curves.* Medicine, Science & the Law, 2016. **56**(1): p. 13-8.	multiple methods	Italy	501	11-16 years
Rai, B., et al., *Age estimation in children by measurement of open apices in teeth: an Indian formula.* International Journal of Legal Medicine, 2010. **124**(3): p. 237-41.	Cameriere	India	480	3-15 years
Rai, B., R. Cameriere, and L. Ferrante, *Accuracy of Cameriere et al regression equation in Haryana population.* Romanian Journal of Legal Medicine, 2009. **17**(2): p. 147-150.	Cameriere	Romania	259	5-15 years
Rai, B., *The evaluation of two radiographic methods for age determination of children in an Indian population.* Journal of Forensic Odonto-Stomatology, 2008. **26**(2): p. 30-3.	multiple methods	India	413	6-16 years
Ramanan, N., et al., *Dental age estimation in Japanese individuals combining permanent teeth and third molars.* Journal of Forensic Odonto-Stomatology, 2012. **30**(2): p. 34-9.	Williems	Japan	1877	1-23 years
Reventlid M, Mornstad H, Teivens AA. Intra- and inter-examiner variations in four dental methods for age estimation of children. Swedish Dental Journal, 1996. 20(4): p. 133-9.	multiple methods	Sweden	197	5-12 years
Rozkovcova, E., et al., *The third molar as an age marker in adolescents: new approach to age evaluation.* Journal of Forensic Sciences, 2012. **57**(5): p. 1323-8.	Kominek	Czech republic	1700	5-21 years
Rozkovcova, E., M. Markova, and L. Mrklas, *Third molar as an age indicator in young individuals.* Prague Medical Report, 2005. **106**(4): p. 367-98.	Kominek & Rozkovcova	Czech republic	900	13-21 years
Sahin Saglam AM, Gazilerli U. The relationship between dental and skeletal maturity. Journal of Orofacial Orthopedics, 2002. 63(6): p. 454-62.	Fishman	Turkey	422	7-15 years
Sarnat, H., et al., *Developmental stages of the third molar in Israeli children.* Pediatric Dentistry, 2003. **25**(4): p. 373-7.	Gat	Israel	693	7-16 years
Schmeling, A., et al., *Dental age estimation based on third molar eruption in First Nation people of Canada.* Journal of Forensic Odonto-Stomatology, 2010. **28**(1): p. 32-8.	Olze	Canada	605	11-29 years
Sequeira, C.D., et al., *Age estimation using the radiographic visibility of the periodontal ligament in lower third molars in a Portuguese population.* Journal of Clinical & Experimental Dentistry, 2014. **6**(5): p. e546-50.	Periodontal ligament method	Portugal	437	17-31 years

Spada, E., et al., *Adapting Haavikko's dental age for the assessment of Italian children: use of LMS and other models based on smoothing splines.* Statistics in Medicine, 2009. **28**(28): p. 3554-61.	Haavikko	Italy	492	5-14 years
Staaf, V., H. Mornstad, and U. Welander, *Age estimation based on tooth development: a test of reliability and validity.* Scandinavian Journal of Dental Research, 1991. **99**(4): p. 281-6.	multiple methods	Sweden	541	5-14 years
Svanholt, M. and I. Kjaer, *Developmental stages of permanent canines, premolars, and 2nd molars in 244 Danish children.* Acta Odontologica Scandinavica, 2008. **66**(6): p. 342-50.	Haavikko	Denmark	244	7-14 years
Teivens A, Mornstad H, Reventlid M. Individual variation of tooth development in Swedish children. Swedish Dental Journal, 1996. 20(3): p. 87-93.	multiple methods	Sweden	197	5-12 years
Thevissen, P.W., et al., *Estimating age of majority on third molars developmental stages in young adults from Thailand using a modified scoring technique.* Journal of Forensic Sciences, 2009. **54**(2): p. 428-32.	Kohler (Gleiser & Hunt modified by Kohler)	Thailand	1199	15-24 years
Thevissen, P.W., et al., *Human dental age estimation using third molar developmental stages: Accuracy of age predictions not using country specific information.* Forensic Science International, 2010. **201**(1): p. 106-11.	Gleiser & Hunt	Belgium	910	16-22 years
Thevissen, P.W., J. Kaur, and G. Willems, *Human age estimation combining third molar and skeletal development.* International Journal of Legal Medicine, 2012. **126**(2): p. 285-92.	Köhler	India	460	3-26 years
Thevissen, P.W., S. Fieuws, and G. Willems, *Human third molars development: Comparison of 9 country specific populations.* Forensic Science International, 2010. **201**(1): p. 102-5.	Gleiser & Hunt	Belgium		16-22 years
Thevissen, P.W., S. Fieuws, and G. Willems, *Third molar development: evaluation of nine tooth development registration techniques for age estimations.* Journal of Forensic Sciences, 2013. **58**(2): p. 393-7.	multiple methods	India	1199	4-34 years
Thevissen, P.W., S. Fieuws, and G. Willems, *Third molar development: measurements versus scores as age predictor.* Archives of Oral Biology, 2011. **56**(10): p. 1035-40.	Kohler (Gleiser & Hunt modified by Kohler)	USA	340	7-24 years
Tian, X., et al., *Dental age estimation of Chinese Han nationality adolescents i n Heilongjiang area. [Chinese].* Chinese Journal of Forensic Medicine, 2010. **25**(2): p. 73-78.	Linear regression model	China	1510	
Tian, X., et al., *Study on the relation between the degree of dental calcification and chronological age about Chinese Han nationality 6 ~18 years old male groups.* Chinese Journal of Forensic Medicine, 2011. **26**(3): p. 180-183.	Linear regression model	China	6923	6-18 years
Timmins, K., et al., *The usefulness of dental and cervical maturation stages in New Zealand children*	multiple methods	New Zealand	200	7-17 years

for Disaster Victim Identification. Forensic Science, Medicine, and Pathology, 2012. **8**(2): p. 101-108.				
Tomas, L.F., et al., *The accuracy of estimating chronological age from Demirjian and Nolla methods in a Portuguese and Spanish sample.* BMC Oral Health, 2014. **14**: p. 160.	multiple methods	Portugal, Spain	821	4-34 years
Tuteja, M., S. Bahirwani, and P. Balaji, *An evaluation of third molar eruption for assessment of chronologic age: A panoramic study.* Journal of forensic dental sciences: JFDS, 2012. **4**(1): p. 13-8.	Olze	India	150	12-26 years
Urzel, V. and J. Bruzek, *Dental age assessment in children: a comparison of four methods in a recent French population.* Journal of Forensic Sciences, 2013. **58**(5): p. 1341-7.	multiple methods	France	743	4-15 years
Van Vlierberghe, M., et al., *A comparative study of two different regression methods for radiographs in Polish youngsters estimating chronological age on third molars.* Forensic Science International, 2010. **201**(1): p. 86-94.	Kohler (Gleiser & Hunt modified by Kohler)	Poland	1048	12-26 years
Veleminska, J., et al., *Dental age estimation and different predictive ability of various tooth types in the Czech population: data mining methods.* Anthropologischer Anzeiger, 2013. **70**(3): p. 331-45.	Moorrrees	Czech	1393	3-17 years
Verochana, K., et al., *Accuracy of an equation for estimating age from mandibular third molar development in a Thai population.* Imaging Science in Dentistry, 2016. **46**(1): p. 1-7.	Gat	Thailand	614	9-20 years
Vidisdottir, S.R. and S. Richter, *Age estimation by dental developmental stages in children and adolescents in Iceland.* Forensic Science International, 2015. **257**: p. 518.e1-7.	Haavikko	Iceland	1000	4-24 years
Wang, Y., S. Huang, and H. Liu, *Use of Haavikko's method to assess dental age in Chinese children.* Community Dental Health, 2011. **28**(2): p. 160-4.	Haavikko	China	613	3-12 years
Willershausen, B., N. Loffler, and R. Schulze, *Analysis of 1202 orthopantograms to evaluate the potential of forensic age determination based on third molar developmental stages.* European Journal of Medical Research, 2001. **6**(9): p. 377-84.	Kullman	Germany	1202	15-24 years
Wolanski, N., *A new method for the evaluation of tooth formation.* Acta Genetica et Statistica Medica, 1966. **16**(2): p. 186-97.	Moorrrees	Poland		
Yusof, M.Y., et al., *Dental age estimation in Malay children based on all permanent teeth types.* International Journal of Legal Medicine, 2014. **128**(2): p. 329-33.	Williems	Malaysian	1403	4-14 years

Appendix 5: Studies excluded after full text assessment

Reference	Reason for exclusion
Abolmasov, N.G., [The role of teeth in the determination of sex and age]. Stomatologiia, 1969. 48(3): p. 78-9.	Not an empirical study published in full text format (abstracts, reviews, other).
Aboshi, H., T. Takahashi, and T. Komuro, Age estimation using microfocus X-ray computed tomography of lower premolars. Forensic Science International, 2010. 200(1): p. 35-40.	Another objective than to compare age estimation by x-ray of teeth (index test) with known chronological age (reference test).
Abouchair, M.M., [Age determination by means of teeth]. Majallat Tibb Al-Asnan Al-Suriyah, 1973. 9(3): p. 65-72.	Another objective than to compare age estimation by x-ray of teeth (index test) with known chronological age (reference test).
Abramowicz, M., [Method for study of age determination]. Revista Da Faculdade de Odontologia Da Universidade de Sao Paulo, 1968. 6(4): p. 257-82.	Another objective than to compare age estimation by x-ray of teeth (index test) with known chronological age (reference test).
Adams, D.M., et al., Impact of population-specific dental development on age estimation. American Journal of Physical Anthropology, 2016. 159: p. 74.	Not an empirical study published in full text format (abstracts, reviews, other).
Agarwal, N., et al., Age estimation using maxillary central incisors: A radiographic study. Journal of forensic dental sciences: JFDS, 2012. 4(2): p. 97-100.	Less than 50 subjects in relevant age range.
Andrews, S.E., Third molar observations in a sample of British male young offenders. Science & Justice, 2015. 55(4): p. 274-8.	Another objective than to compare age estimation by x-ray of teeth (index test) with known chronological age (reference test).
Artis, O., H. Coudane, and J.P. Artis, Estimation of the age from the stage of development of wisdom teeth, in a caucasian population of the north-east of France. [French]. Journal de Medecine Legale Droit Medical, 2007. 50(8): p. 399-407.	Another objective than to compare age estimation by x-ray of teeth (index test) with known chronological age (reference test).
Azevedo Ade, C., et al., Dental age estimation in a Brazilian adult population using Cameriere's method. Pesquisa Odontologica Brasileira = Brazilian Oral Research, 2015. 29.	Less than 50 subjects in relevant age range.
Azevedo, A.C., et al., Accuracy and reliability of pulp/tooth area ratio in upper canines by peri-apical X-rays. Legal Medicine, 2014. 16(6): p. 337-43.	The study population is not living persons between the ages of 10 to 25 years old.
Azrak, B., et al., Usefulness of combining clinical and radiological dental findings for a more accurate noninvasive age estimation. Journal of Forensic Sciences, 2007. 52(1): p. 146-50.	Another objective than to compare age estimation by x-ray of teeth (index test) with known chronological age (reference test).
Babshet, M., A.B. Acharya, and V.G. Naikmasur, Age estimation from pulp/tooth area ratio (PTR) in an Indian sample: A preliminary comparison of three mandibular teeth used alone and in combination. Journal of Forensic and Legal Medicine, 2011. 18(8): p. 350-354.	Less than 50 subjects in relevant age range.
Babshet, M., A.B. Acharya, and V.G. Naikmasur, Age estimation in Indians from pulp/tooth area ratio of mandibular canines. Forensic Science International, 2010. 197(1): p. 125.e1-4.	Less than 50 subjects in relevant age range.
Bassed, R.B., C. Briggs, and O.H. Drummer, Age estimation and the developing third molar tooth: an analysis of an Australian population using computed tomography. Journal of Forensic Sciences, 2011. 56(5): p. 1185-91.	The study population is not living persons between the ages of 10 to 25 years old.
Batterson, K.D., et al., The effect of chronic methylphenidate administration on tooth maturation in a sample of Caucasian children. Pediatric Dentistry, 2005. 27(4): p. 292-7.	Less than 50 subjects in relevant age range.

Baumann, P., et al., Dental age estimation of living persons: Comparison of MRI with OPG. Forensic Science International, 2015. 253: p. 76-80.	Less than 50 subjects in relevant age range.
Bezerra IS, Topolski F, Franca SN, Brucker MR, Fernandes A. Assessment of skeletal and dental ages of children and adolescents with type 1 diabetes mellitus. Pesquisa Odontologica Brasileira = Brazilian Oral Research. 2015;29.	A study population with chronic diseases or developmental disorders.
Birchler, F.A., et al., Dental age assessment on panoramic radiographs in a Swiss population: a validation study of two prediction models. Dento-Maxillo-Facial Radiology, 2016. 45(1): p. 20150137.	Less than 50 subjects in relevant age range.
Borodkin, A.F., et al., Permanent tooth development in children with cleft lip and palate. Pediatric Dentistry, 2008. 30(5): p. 408-13.	Less than 50 subjects in relevant age range.
Boutourline E, Tesi G, Kerr GR, Ghamry MT, Stare FJ, Kallal Z, et al. Nutritional correlates of child development in Southern Tunisia. 3. Skeletal growth and maturation. Growth. 1973;37(3):223-47.	Another objective than to compare age estimation by x-ray of teeth (index test) with known chronological age (reference test).
Burns, K.R. and W.R. Maples, Estimation of age from individual adult teeth. Journal of Forensic Sciences, 1976. 21(2): p. 343-56.	The study population is not living persons between the ages of 10 to 25 years old.
Cameriere R, De Luca S, Egidi N, Bacaloni M, Maponi P, Ferrante L, et al. Automatic age estimation in adults by analysis of canine pulp/tooth ratio: Preliminary results. Journal of Forensic Radiology and Imaging. 2015;3(1):61-6.	Another objective than to compare age estimation by x-ray of teeth (index test) with known chronological age (reference test).
Cameriere, R., et al., Age estimation by pulp/tooth ratio in canines by mesial and vestibular peri-apical X-rays. Journal of Forensic Sciences, 2007. 52(5): p. 1151-5.	The study population is not living persons between the ages of 10 to 25 years old.
Cameriere, R., et al., Age estimation by pulp/tooth ratio in canines by peri-apical X-rays. Journal of Forensic Sciences, 2007. 52(1): p. 166-70.	The study population is not living persons between the ages of 10 to 25 years old.
Cameriere, R., et al., Age estimation by pulp/tooth ratio in lower premolars by orthopantomography. Forensic Science International, 2012. 214(1): p. 105-12.	Another objective than to compare age estimation by x-ray of teeth (index test) with known chronological age (reference test).
Cameriere, R., L. Ferrante, and M. Cingolani, Variations in pulp/tooth area ratio as an indicator of age: a preliminary study. Journal of Forensic Sciences, 2004. 49(2): p. 317-9.	Less than 50 subjects in relevant age range.
Cardoso, H.F.V., Accuracy of developing tooth length as an estimate of age in human skeletal remains: The ermanent ntition. American Journal of Forensic Medicine and Pathology, 2009. 30(2): p. 127-133.	The study population is not living persons between the ages of 10 to 25 years old.
Carels, C.E., et al., Age reference charts of tooth length in Dutch children. Journal de Biologie Buccale, 1991. 19(4): p. 297-303.	Another objective than to compare age estimation by x-ray of teeth (index test) with known chronological age (reference test).
Cheraskin, E. and W.M. Ringsdorf, Jr., Ageing by the teeth. Lancet, 1969. 1(7594): p. 580.	Not an empirical study published in full text format (abstracts, reviews, other).
Chertkow S. Tooth mineralization as an indicator of the pubertal growth spurt. American Journal of Orthodontics. 1980;77(1):79-91.	Another objective than to compare age estimation by x-ray of teeth (index test) with known chronological age (reference test).
Clement, J., Summary of: estimating age and the likelihood of having attained 18 years of age using mandibular third molars. British Dental Journal, 2010. 209(8): p. 406-7.	Not an empirical study published in full text format (abstracts, reviews, other).
Crossner, C.G. and L. Mansfeld, Determination of dental age in adopted non-European children. [Swedish]. Lakartidningen, 1983. 80(17): p. 1810-1817.	Less than 50 subjects in relevant age range.

Daugaard, S., I.J. Christensen, and I. Kjaer, Delayed dental maturity in dentitions with agenesis of mandibular second premolars. Orthodontics and Craniofacial Research, 2010. 13(4): p. 191-196.	A study population with chronic diseases or developmental disorders.
De Angelis, D., et al., Application of age estimation methods based on teeth eruption: how easy is Olze method to use? International Journal of Legal Medicine, 2014. 128(5): p. 841-4.	Less than 50 subjects in relevant age range.
de Souza, R.B., et al., Dental age estimation in Brazilian HIV children using Willems' method. Forensic Science International, 2015. 257: p. 510.e1-4.	Another objective than to compare age estimation by x-ray of teeth (index test) with known chronological age (reference test).
Demirjian A, Buschang PH, Tanguay R, Patterson DK. Interrelationships among measures of somatic, skeletal, dental, and sexual maturity. American Journal of Orthodontics. 1985;88(5):433-8.	Less than 50 subjects in relevant age range.
Di Lorenzo P, Niola M, Pantaleo G, Buccelli C, Amato M. On the comparison of age determination methods based on dental development radiographic studies in a sample of Italian population. Dental Cadmos. 2015;83(1):38-45.	Another objective than to compare age estimation by x-ray of teeth (index test) with known chronological age (reference test).
Dogaroiu, C., et al., Age estimation in subadults using teeth eruption examination. Romanian Journal of Legal Medicine, 2015. 23(1): p. 49-56.	Less than 50 subjects in relevant age range.
Du, C., Y. Zhu, and L. Hong, Age-related changes in pulp cavity of incisors as a determinant for forensic age identification. Journal of Forensic Sciences, 2011. 56: p. S72-6.	Less than 50 subjects in relevant age range.
Duric, M., Z. Rakocevic, and N. Rankovic, [Age assessment at the time of death based on panoramic radiography]. Vojnosanitetski Pregled, 2005. 62(7): p. 557-64.	Less than 50 subjects in relevant age range.
Erbudak, H.O., et al., Application of Kvaal et al.'s age estimation method to panoramic radiographs from Turkish individuals. Forensic Science International, 2012. 219(1): p. 141-6.	Less than 50 subjects in relevant age range.
Espina-Fereira A, Ortega AI, Barrios FA, Maldonado YJ, Fereira JL. [Metric and angular variables of the mandibular ramus on panoramic radiographs, as indicators for chronologic age]. Investigacion Clinica. 2007;48(4):403-18.	Another objective than to compare age estimation by x-ray of teeth (index test) with known chronological age (reference test).
Fan, J.L. and W.L. Zhou, Validity and reliability of the Demirjian distinguish software on estimating dental age. [Chinese]. Zhongguo yi xue ke xue yuan xue bao, 2005. 0(3): p. 363-366.	Another objective than to compare age estimation by x-ray of teeth (index test) with known chronological age (reference test).
Fanning, E.A., Most cited: number 1. A longitudinal study of tooth formation and root resorption. New Zealand Dental Journal, 2008. 104(2): p. 60-1.	Not an empirical study published in full text format (abstracts, reviews, other).
Fayad, J.B., et al., Eruption of third molars: Relationship to inclination of adjacent molars. American Journal of Orthodontics and Dentofacial Orthopedics, 2004. 125(2): p. 200-202.	Another objective than to compare age estimation by x-ray of teeth (index test) with known chronological age (reference test).
Fieuws S, Willems G, Larsen-Tangmose S, Lynnerup N, Boldsen J, Thevissen P. Obtaining appropriate interval estimates for age when multiple indicators are used: evaluation of an ad-hoc procedure. International Journal of Legal Medicine. 2016;130(2):489-99.	Another objective than to compare age estimation by x-ray of teeth (index test) with known chronological age (reference test).
Foti, B., et al., New forensic approach to age determination in children based on tooth eruption. Forensic Science International, 2003. 132(1): p. 49-56.	Another objective than to compare age estimation by x-ray of teeth (index test) with known chronological age (reference test).
Foti, B., et al., Probabilist approach of children age determination. Comptes Rendus - Biologies, 2003. 326(4): p. 441-448.	Another objective than to compare age estimation by x-ray of teeth (index test) with known chronological age (reference test).

Franchi, L., et al., Phases of the dentition for the assessment of skeletal maturity: A diagnostic performance study. American Journal of Orthodontics and Dentofacial Orthopedics, 2008. 133(3): p. 395-400.	Another objective than to compare age estimation by x-ray of teeth (index test) with known chronological age (reference test).
Franco, A., et al., Applicability of Willems model for dental age estimations in Brazilian children. Forensic Science International, 2013. 231(1): p. 401.e1-4.	Another objective than to compare age estimation by x-ray of teeth (index test) with known chronological age (reference test).
Freitas, J.A., et al., [Forensic use of chronological tooth eruption tables]. Estomatologia e Cultura, 1970. 4(2): p. 181-200.	Another objective than to compare age estimation by x-ray of teeth (index test) with known chronological age (reference test).
Friedrich, R.E., C. Ulbricht, and A.B.v.M. Ljuba, The influence of wisdom tooth impaction on root formation. Annals of Anatomy, 2003. 185(5): p. 481-92.	Another objective than to compare age estimation by x-ray of teeth (index test) with known chronological age (reference test).
Friedrich, R.E., et al., [The impact of wisdom teeth topography on chronology of root formation--forensic consequence for forensic-odontologic age estimation of adolescents and young adults. Radiographic investigations using orthopantomography]. Archiv fur Kriminologie, 2005. 216(1): p. 15-35.	Another objective than to compare age estimation by x-ray of teeth (index test) with known chronological age (reference test).
Friedrich, R.E., S. Habib, and H.A. Scheuer, [Eruption times of permanent teeth in children and adolescents in Latakia (Syria)]. Archiv fur Kriminologie, 2009. 223(3): p. 84-97.	Another objective than to compare age estimation by x-ray of teeth (index test) with known chronological age (reference test).
Gaethofs, M., et al., Delayed dental age in boys with constitutionally delayed puberty. European Journal of Orthodontics, 1999. 21(6): p. 711-5.	Less than 50 subjects in relevant age range.
Gandhi, N., et al., Reliability of third molar development for age estimation in Gujarati population: A comparative study. Journal of forensic dental sciences : JFDS, 2015. 7(2): p. 107-13.	Less than 50 subjects in relevant age range.
Gat, H., et al., Dental age evaluation. A new six-developmental-stage method. Clinical Preventive Dentistry, 1984. 6(2): p. 18-22.	Another objective than to compare age estimation by x-ray of teeth (index test) with known chronological age (reference test).
Ge, Z.P., et al., Age estimation based on pulp chamber volume of first molars from cone-beam computed tomography images. Forensic Science International, 2015. 253: p. 133.e1-7.	Another objective than to compare age estimation by x-ray of teeth (index test) with known chronological age (reference test).
Gelbrich, B., et al., Agenesis of second premolars and delayed dental maturation. Journal of Orofacial Orthopedics, 2015. 76(4): p. 338-50.	Another objective than to compare age estimation by x-ray of teeth (index test) with known chronological age (reference test).
Giri J, Shrestha BK, Yadav R, Ghimire TR. Assessment of skeletal maturation with permanent mandibular second molar calcification stages among a group of Nepalese orthodontic patients. Clinical Cosmetic & Investigational Dentistry. 2016;8:57-62.	Not an empirical study published in full text format (abstracts, reviews, other).
Graham, J.P., et al., The application of computerized tomography (CT) to the dental ageing of children and adolescents. Forensic Science International, 2010. 195(1): p. 58-62.	Another objective than to compare age estimation by x-ray of teeth (index test) with known chronological age (reference test).
Guo, Y., et al., Dental age estimation in living individuals using 3.0 T MRI of lower third molars. International Journal of Legal Medicine, 2015. 129(6): p. 1265-70.	Another objective than to compare age estimation by x-ray of teeth (index test) with known chronological age (reference test).
Gupta S, Chada MK, Sharma A. Assessment of puberty growth spurt in boys and girls--a dental radiographic method. Journal of the Indian Society of Pedodontics & Preventive Dentistry. 1995;13(1):4-9.	Another objective than to compare age estimation by x-ray of teeth (index test) with known chronological age (reference test).

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Poornima, G., S. , and L. Ashok, Assessment of age by measuring variation in pulp tooth area ratio - an orthopantomographic study. Indian Journal of Forensic Medicine and Toxicology, 2011. 5(2): p. 75-79.	The study population is not living persons between the ages of 10 to 25 years old.
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Rajpal, P.S., et al., Age estimation using intraoral periapical radiographs. Journal of forensic dental sciences: JFDS, 2016. 8(1): p. 56-7.	Less than 50 subjects in relevant age range.
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Talabani, R.M., M.T. Baban, and M.A. Mahmood, Age estimation using lower permanent first molars on a panoramic radiograph: A digital image analysis. Journal of forensic dental sciences: JFDS, 2015. 7(2): p. 158-62.	Less than 50 subjects in relevant age range.
Tan, Y., et al., [Relationship between dental calcification stages of the third molar and ages among teenagers in Chengdu]. Hua Xi Kou Qiang Yi Xue Za Zhi, 2013. 31(3): p. 272-4, 278.	Another objective than to compare age estimation by x-ray of teeth (index test) with known chronological age (reference test).
Tardivo, D., et al., Age determination of adult individuals by three-dimensional modelling of canines. International Journal of Legal Medicine, 2014. 128(1): p. 161-9.	Another objective than to compare age estimation by x-ray of teeth (index test) with known chronological age (reference test).
Tenenbaum M, Gabriel R. [Panoramic evaluation of bone age determination using dental radiographs]. Ortodoncia. 1981. 45(90): p. 21-9.	Another objective than to compare age estimation by x-ray of teeth (index test) with known chronological age (reference test).
Thevissen, P.W., D. Galiti, and G. Willems, Human dental age estimation combining third molar(s) development and tooth morphological age predictors. International Journal of Legal Medicine, 2012. 126(6): p. 883-7.	Less than 50 subjects in relevant age range.
Thevissen, P.W., S. Fieuws, and G. Willems, Human dental age estimation using third molar developmental stages: does a Bayesian approach outperform regression models to discriminate between juveniles and adults? International Journal of Legal Medicine, 2010. 124(1): p. 35-42.	Another objective than to compare age estimation by x-ray of teeth (index test) with known chronological age (reference test).
Trevino-Tijerina, M.C., et al., Age estimation of teenagers from Monterrey (Mexico) by the evaluation of dental mineralization after multi-slice helical computed tomography. Australian Journal of Forensic Sciences, 2016. 48(2): p. 138-149.	Another objective than to compare age estimation by x-ray of teeth (index test) with known chronological age (reference test).
Tunc, E.S., S. Bayrak, and A.E. Koyuturk, Dental development in children with mild-to-moderate hypodontia. American Journal of Orthodontics and Dentofacial Orthopedics, 2011. 139(3): p. 334-338.	A study population with chronic diseases or developmental disorders.
Uslenghi, S., H.M. Liversidge, and F.S. Wong, A radiographic study of tooth development in hypodontia. Archives of Oral Biology, 2006. 51(2): p. 129-33.	Less than 50 subjects in relevant age range.
Uysal, T., A. Yagci, and S.I. Ramoglu, Dental maturation in patients with unilateral posterior crossbite. World Journal of Orthodontics, 2009. 10(4): p. 383-8.	Less than 50 subjects in relevant age range.
Uzuner, F.D., et al., Radiographic evaluation of third molar development in relation to chronological age, gender and jaws. Journal of Oral and Maxillofacial Surgery, 2014. 1: p. e80-e81.	Not an empirical study published in full text format (abstracts, reviews, other).
Vaindrukh, S.A., [Determination of age in 5-15 year old children based on roentgenologic examination of tooth development]. Sudebno-Meditsinskaia Ekspertiza, 1965. 8(3): p. 20-4.	Less than 50 subjects in relevant age range.
Vasconcelos, N.P., et al., Dental maturity assessment in children with acute lymphoblastic leukemia after cancer therapy. Forensic Science International, 2009. 184(1): p. 10-4.	A study population with chronic diseases or developmental disorders.
Wang, M.T.A., et al., Discrepancy between chronological age and evaluated dental age using the Demirjian system in Western Australian children. Australian Journal of Forensic Sciences, 2015. 47(4): p. 469-474.	Less than 50 subjects in relevant age range.
Wedl, J.S., V. Schoder, and R.E. Friedrich, [Tooth eruption times of permanent teeth in male and female adolescents in Niedersachsen]. Archiv fur Kriminologie, 2004. 213(3): p. 84-91.	Another objective than to compare age estimation by x-ray of teeth (index test) with known chronological age (reference test).

Wenzel, A., A. Thylstrup, and B. Melsen, Skeletal development and dental fluorosis in 12--14-year-old Danish girls from a fluoride and a non-fluoride community. Scandinavian Journal of Dental Research, 1982. 90(2): p. 83-8.	Another objective than to compare age estimation by x-ray of teeth (index test) with known chronological age (reference test).
Woods, E., et al., The dental development in patients with Aperts syndrome. International Journal of Paediatric Dentistry, 2015. 25(2): p. 136-43.	Less than 50 subjects in relevant age range.
Xiaohu, X., et al., Age estimation by Chinese permanent teeth with image analysis. Medicine, Science and the Law, 1994. 34(4): p. 284-288.	Another objective than to compare age estimation by x-ray of teeth (index test) with known chronological age (reference test).
Yadava, M., G.J. Roberts, and V.S. Lucas, Dental age assessment (DAA): reference data for British children at the 10-year-old threshold. International Journal of Legal Medicine, 2011. 125(5): p. 651-7.	Less than 50 subjects in relevant age range.
Yan, J., et al., Assessment of dental age of children aged 3.5 to 16.9 years using Demirjian's method: A meta-analysis based on 26 studies. PLoS ONE, 2013. 8.	Not an empirical study published in full text format (abstracts, reviews, other).
Zaher, J.F., et al., Age estimation from pulp/tooth area ratio in maxillary incisors among Egyptians using dental radiographic images. Journal of Forensic and Legal Medicine, 2011. 18(2): p. 62-65.	Less than 50 subjects in relevant age range.
Zatylna, N., K. Rogowska, and A. Kozanecka, Comparison of 6-12 year old girls' and boys' dental age using Demirijan's method. Dental and Medical Problems, 2013. 50(1): p. 64-70.	Less than 50 subjects in relevant age range.
Zhang, S., et al., [Relationships between dental calcification stages and cervical vertebral bone ages among children and adolescents in Chengdu]. Hua Xi Kou Qiang Yi Xue Za Zhi, 2012. 30(6): p. 620-3.	Not an empirical study published in full text format (abstracts, reviews, other).

References that we did not consider because the full text articles were expensive or difficult to procure:
A., Age determination by dental examination. [Spanish]. Revista dental, 1972. 19(56): p. 34-36.
Biradar, S.S., et al., Age estimation by eruption and apical foramina closure of second premolar teeth. Medico-Legal Update, 2012. 12(1): p. 120-122.
Kosiuga SI, Bogomolova ES, Kiseleva OS, Krivulina GV, Sorokina IS. [Dental criteria for estimation of biological age in children and adolescents]. [Russian]. Stomatologii combining double inverted brevea. 2013. 92(6): p. 56-8.
Limdiwala, P.G. and J.S. Shah, Age estimation by using dental radiographs. Journal of forensic dental sciences: JFDS, 2013. 5(2): p. 118-22.
Liu, Z., Age estimation by teeth. [Chinese]. Zhonghua kou qiang ke za zhi [Chinese journal of stomatology], 1984. 19(1): p. 50-52.
Rai, B., S.K. Dhattarwal, and S.C. Anand, Accuracy of Demirjian method for north Indian population. Medico-Legal Update, 2007. 7(4): p. 119-121.
Scheurer, E., et al., Dental age estimation in living persons: Validation of reference data on mineralization and eruption. Rechtsmedizin, 2011. 21: p. 364.
Wolanski, N., New method for the evaluation of tooth formation. Journal of Dental Research, 1967. 46(5): p. 875.

Appendix 6: All analysed results

Mean chronological age for boys in Demirjian's development stages A-H

In figures A1-A8, the point estimates are the mean, the horizontal lines show ± 1 standard deviation and the parenthesises the upper and lower 95% confidence interval of the mean.

SD: Standard deviation; CI: Confidence interval of the mean difference; UR8 (18): Upper right third molar; UL8 (28): Upper left third molar; LL8 (38): Lower left third molar; LR8 (48): Lower right third molar.

Figure A1: Mean chronological age for boys in Demirjian's development stage A for all four third molars from each of the included studies (if data available from article).

Gender=Male − Stage=A

Study	Year	Country	Tooth	Size	SD	Mean [95% CI]
Meinl	2007	Austria	UR8			
Meinl	2007	Austria	UL8			
Meinl	2007	Austria	LL8			
Meinl	2007	Austria	LR8			
Lopez	2013	Brazil	UR8			
Lopez	2013	Brazil	UL8			
Lopez	2013	Brazil	LL8			
Lopez	2013	Brazil	LR8			
Zeng	2010	China	UR8	25	1.5	10.49 [9.9,11.08]
Zeng	2010	China	UL8	30	1.41	10.03 [9.53,10.53]
Zeng	2010	China	LL8	63	1.47	9.82 [9.46,10.18]
Zeng	2010	China	LR8	54	1.66	9.86 [9.42,10.3]
Li	2012	China	UR8	25	2.3	10 [9.1,10.9]
Li	2012	China	UL8	21	2	9.7 [8.84,10.56]
Li	2012	China	LL8	45	1.6	9.4 [8.93,9.87]
Li	2012	China	LR8	45	1.7	9.8 [9.3,10.3]
Guo	2014	China	UR8			
Guo	2014	China	UL8			
Guo	2014	China	LL8			
Guo	2014	China	LR8			
Guo	2015	China	UR8	13	1.97	11.31 [10.24,12.38]
Guo	2015	China	UL8	13	1.21	9.85 [9.19,10.51]
Guo	2015	China	LL8	72	1.56	10.06 [9.7,10.42]
Guo	2015	China	LR8	70	1.5	10.11 [9.76,10.46]
Rouge−Maillart	2011	France	UR8			
Rouge−Maillart	2011	France	UL8			
Rouge−Maillart	2011	France	LL8			
Rouge−Maillart	2011	France	LR8			
Zandi	2015	Iran	UR8	29	1.52	9.52 [8.97,10.07]
Zandi	2015	Iran	UL8	31	1.53	9.32 [8.78,9.86]
Zandi	2015	Iran	LL8	61	1.56	9.64 [9.25,10.03]
Zandi	2015	Iran	LR8	61	1.49	9.72 [9.35,10.09]
Johan	2012	Malaysia	UR8			
Johan	2012	Malaysia	UL8			
Johan	2012	Malaysia	LL8			
Johan	2012	Malaysia	LR8			
Elshehawi	2016	Malta	UR8	4	0.38	9.41 [9.04,9.78]
Elshehawi	2016	Malta	UL8	3	0.39	10.13 [9.69,10.57]
Elshehawi	2016	Malta	LL8	18	1.9	10.3 [9.42,11.18]
Elshehawi	2016	Malta	LR8	25	1.65	10.47 [9.82,11.12]
Olze	2010	Native Canada	UR8			
Olze	2010	Native Canada	UL8			
Olze	2010	Native Canada	LL8			
Olze	2010	Native Canada	LR8			
Olze	2006	South Africa	UR8			
Olze	2006	South Africa	UL8			
Olze	2006	South Africa	LL8			
Olze	2006	South Africa	LR8			
Olze	2012	South Africa	UR8			
Olze	2012	South Africa	UL8			
Olze	2012	South Africa	LL8			
Olze	2012	South Africa	LR8			
Lee	2009	South Korea	UR8	54	1.1	9.9 [9.61,10.19]
Lee	2009	South Korea	UL8	60	1.3	10.1 [9.77,10.43]
Lee	2009	South Korea	LL8	65	1.4	10.1 [9.76,10.44]
Lee	2009	South Korea	LR8	67	1.3	10.1 [9.79,10.41]
Prieto	2004	Spain	UR8			
Prieto	2004	Spain	UL8			
Prieto	2004	Spain	LL8			
Prieto	2004	Spain	LR8			
Karatas	2013	Turkey	UR8	72	1.36	8.69 [8.38,9]
Karatas	2013	Turkey	UL8	86	1.4	8.86 [8.56,9.16]
Karatas	2013	Turkey	LL8	108	1.31	8.97 [8.72,9.22]
Karatas	2013	Turkey	LR8	117	1.42	9.14 [8.88,9.4]
Karadayi	2014	Turkey	UR8			
Karadayi	2014	Turkey	UL8			
Karadayi	2014	Turkey	LL8	34	0.78	9.62 [9.36,9.88]
Karadayi	2014	Turkey	LR8			
Boonpitaksathit	2011	UK	UR8			
Boonpitaksathit	2011	UK	UL8			
Boonpitaksathit	2011	UK	LL8			
Boonpitaksathit	2011	UK	LR8			

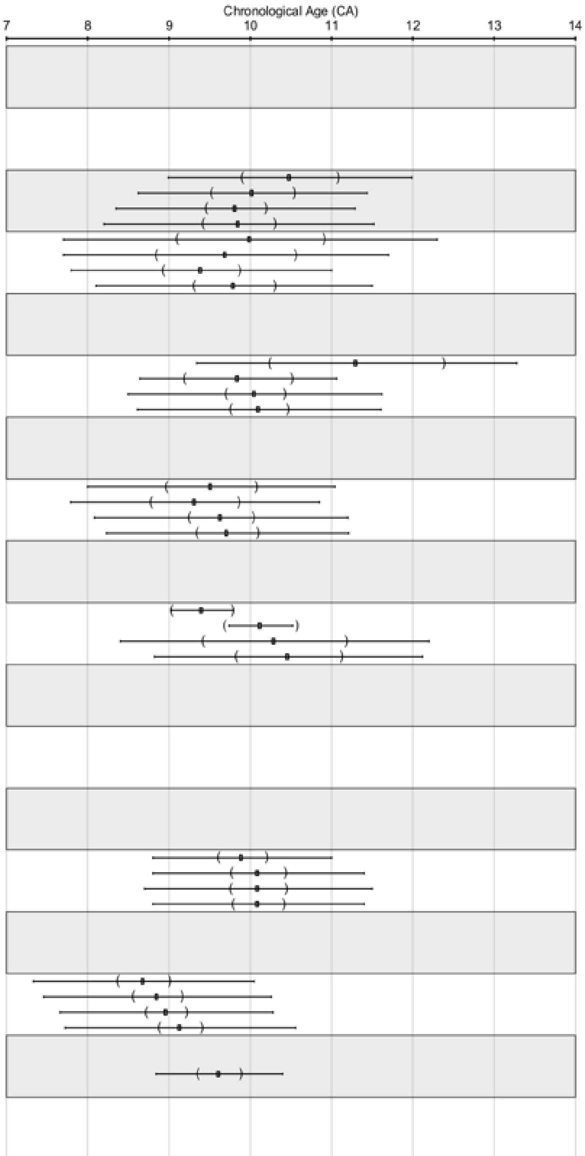


Figure A2: Mean chronological age for boys in Demirjian's development stage B for all four third molars from each of the included studies (if data available from article).

Gender=Male – Stage=B

Study	Year	Country	Tooth	Size	SD	Mean [95% CI]
Meinl	2007	Austria	UR8			
Meinl	2007	Austria	UL8			
Meinl	2007	Austria	LL8	4	0.4	12.7 [12.31,13.09]
Meinl	2007	Austria	LR8	4	0.4	12.7 [12.31,13.09]
Lopez	2013	Brazil	UR8			
Lopez	2013	Brazil	UL8	1	0	16.1
Lopez	2013	Brazil	LL8			
Lopez	2013	Brazil	LR8			
Zeng	2010	China	UR8	63	1.5	10.6 [10.23,10.97]
Zeng	2010	China	UL8	63	1.55	10.98 [10.6,11.36]
Zeng	2010	China	LL8	105	1.67	11.1 [10.78,11.42]
Zeng	2010	China	LR8	105	1.5	10.92 [10.63,11.21]
Li	2012	China	UR8	38	2.1	11.1 [10.43,11.77]
Li	2012	China	UL8	43	1.6	11 [10.52,11.48]
Li	2012	China	LL8	63	1.8	10.9 [10.46,11.34]
Li	2012	China	LR8	58	1.6	10.5 [10.09,10.91]
Guo	2014	China	UR8			
Guo	2014	China	UL8			
Guo	2014	China	LL8			
Guo	2014	China	LR8			
Guo	2015	China	UR8	38	1.16	11 [10.63,11.37]
Guo	2015	China	UL8	41	1.56	11.22 [10.74,11.7]
Guo	2015	China	LL8	15	1.64	10.47 [9.64,11.3]
Guo	2015	China	LR8	16	1.25	10.31 [9.7,10.92]
Rouge−Maillart	2011	France	UR8			
Rouge−Maillart	2011	France	UL8			
Rouge−Maillart	2011	France	LL8			
Rouge−Maillart	2011	France	LR8			
Zandi	2015	Iran	UR8	53	1.24	10.26 [9.93,10.59]
Zandi	2015	Iran	UL8	66	1.67	10.53 [10.13,10.93]
Zandi	2015	Iran	LL8	95	1.27	10.46 [10.2,10.72]
Zandi	2015	Iran	LR8	90	1.22	10.56 [10.31,10.81]
Johan	2012	Malaysia	UR8			
Johan	2012	Malaysia	UL8			
Johan	2012	Malaysia	LL8			
Johan	2012	Malaysia	LR8			
Elshehawi	2016	Malta	UR8	59	1.39	11.4 [11.05,11.75]
Elshehawi	2016	Malta	UL8	60	1.33	11.35 [11.01,11.69]
Elshehawi	2016	Malta	LL8	68	1.24	11.19 [10.9,11.48]
Elshehawi	2016	Malta	LR8	59	1.19	11.14 [10.84,11.44]
Olze	2010	Native Canada	UR8			
Olze	2010	Native Canada	UL8			
Olze	2010	Native Canada	LL8			
Olze	2010	Native Canada	LR8			
Olze	2006	South Africa	UR8			
Olze	2006	South Africa	UL8			
Olze	2006	South Africa	LL8			
Olze	2006	South Africa	LR8			
Olze	2012	South Africa	UR8			
Olze	2012	South Africa	UL8			
Olze	2012	South Africa	LL8			
Olze	2012	South Africa	LR8			
Lee	2009	South Korea	UR8	55	1.3	11 [10.66,11.34]
Lee	2009	South Korea	UL8	59	1.2	11.1 [10.79,11.41]
Lee	2009	South Korea	LL8	58	1.3	11.1 [10.77,11.43]
Lee	2009	South Korea	LR8	57	1.5	11.2 [10.81,11.59]
Prieto	2004	Spain	UR8			
Prieto	2004	Spain	UL8			
Prieto	2004	Spain	LL8			
Prieto	2004	Spain	LR8			
Karatas	2013	Turkey	UR8	96	1.28	10.16 [9.9,10.42]
Karatas	2013	Turkey	UL8	85	1.27	10.28 [10.01,10.55]
Karatas	2013	Turkey	LL8	93	1.31	10.66 [10.39,10.93]
Karatas	2013	Turkey	LR8	90	1.39	10.77 [10.48,11.06]
Karadayi	2014	Turkey	UR8			
Karadayi	2014	Turkey	UL8			
Karadayi	2014	Turkey	LL8	45	1.15	10.39 [10.05,10.73]
Karadayi	2014	Turkey	LR8			
Boonpitaksathit	2011	UK	UR8			
Boonpitaksathit	2011	UK	UL8			
Boonpitaksathit	2011	UK	LL8			
Boonpitaksathit	2011	UK	LR8			

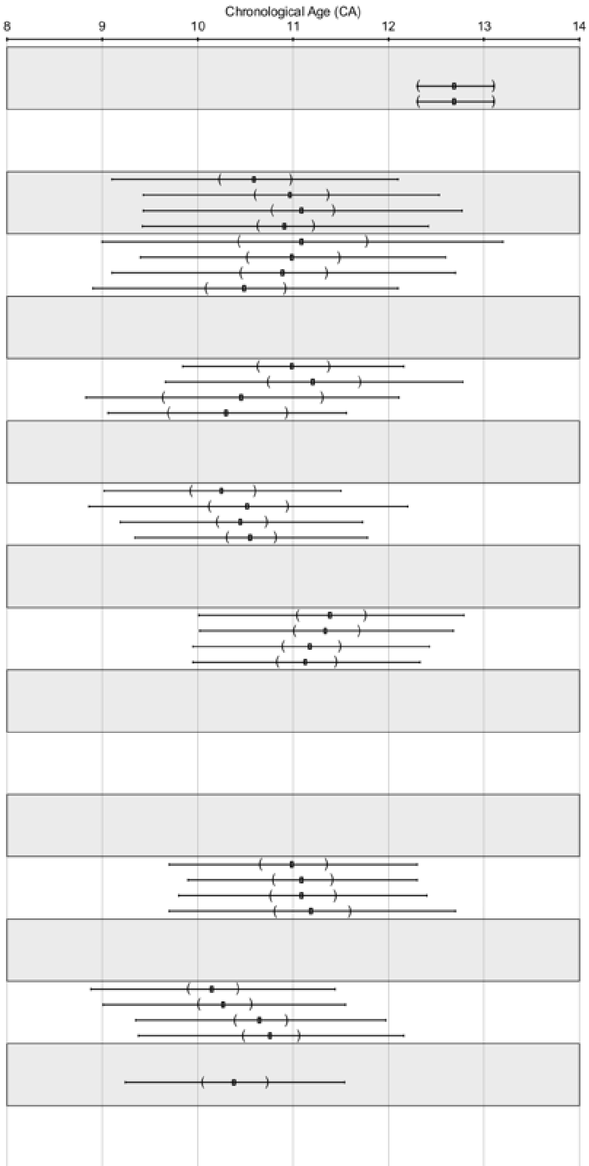


Figure A3: Mean chronological age for boys in Demirjian's development stage C for all four third molars from each of the included studies (if data available from article).

Gender=Male − Stage=C

Study	Year	Country	Tooth	Size	SD	Mean [95% CI]
Meinl	2007	Austria	UR8			
Meinl	2007	Austria	UL8			
Meinl	2007	Austria	LL8	10	1	13.7 [13.08,14.32]
Meinl	2007	Austria	LR8	8	1	13.5 [12.81,14.19]
Lopez	2013	Brazil	UR8			
Lopez	2013	Brazil	UL8	1	0	16.1
Lopez	2013	Brazil	LL8	5	0.47	15.6 [15.19,16.01]
Lopez	2013	Brazil	LR8	5	2.92	16.9 [14.34,19.46]
Zeng	2010	China	UR8	226	1.43	12.44 [12.25,12.63]
Zeng	2010	China	UL8	233	1.33	12.51 [12.34,12.68]
Zeng	2010	China	LL8	260	1.31	12.55 [12.39,12.71]
Zeng	2010	China	LR8	263	1.33	12.57 [12.41,12.73]
Li	2012	China	UR8	76	1.9	12.8 [12.37,13.23]
Li	2012	China	UL8	71	2.2	12.8 [12.29,13.31]
Li	2012	China	LL8	130	1.8	12.6 [12.29,12.91]
Li	2012	China	LR8	115	1.8	12.5 [12.17,12.83]
Guo	2014	China	UR8	87	1.39	12.25 [11.96,12.54]
Guo	2014	China	UL8	85	1.15	12.09 [11.84,12.33]
Guo	2014	China	LL8	132	1.49	12.4 [12.15,12.65]
Guo	2014	China	LR8	130	1.22	12.24 [12.03,12.45]
Guo	2015	China	UR8	94	1.22	11.98 [11.73,12.23]
Guo	2015	China	UL8	97	1.31	11.8 [11.54,12.06]
Guo	2015	China	LL8	150	1.65	12.08 [11.82,12.34]
Guo	2015	China	LR8	144	1.35	12.01 [11.79,12.23]
Rouge−Maillart	2011	France	UR8	1	0	15.8
Rouge−Maillart	2011	France	UL8	1	0	15.8
Rouge−Maillart	2011	France	LL8			
Rouge−Maillart	2011	France	LR8	1	0	15.8
Zandi	2015	Iran	UR8	55	1.35	11.27 [10.91,11.63]
Zandi	2015	Iran	UL8	48	1.27	11.21 [10.85,11.57]
Zandi	2015	Iran	LL8	44	1.75	11.85 [11.33,12.37]
Zandi	2015	Iran	LR8	44	1.83	11.86 [11.32,12.4]
Johan	2012	Malaysia	UR8			
Johan	2012	Malaysia	UL8			
Johan	2012	Malaysia	LL8	19	0.77	14.53 [14.18,14.88]
Johan	2012	Malaysia	LR8	19	0.77	14.53 [14.18,14.88]
Elshehawi	2016	Malta	UR8	95	1.73	12.53 [12.18,12.88]
Elshehawi	2016	Malta	UL8	94	1.57	12.42 [12.1,12.74]
Elshehawi	2016	Malta	LL8	115	1.42	12.46 [12.2,12.72]
Elshehawi	2016	Malta	LR8	116	1.42	12.53 [12.27,12.79]
Olze	2010	Native Canada	UR8	5	0.6	12.7 [12.17,13.23]
Olze	2010	Native Canada	UL8	6	0.4	12.4 [12.08,12.72]
Olze	2010	Native Canada	LL8	2	0.5	12.5 [11.81,13.19]
Olze	2010	Native Canada	LR8			
Olze	2006	South Africa	UR8			
Olze	2006	South Africa	UL8			
Olze	2006	South Africa	LL8			
Olze	2006	South Africa	LR8			
Olze	2012	South Africa	UR8			
Olze	2012	South Africa	UL8			
Olze	2012	South Africa	LL8			
Olze	2012	South Africa	LR8			
Lee	2009	South Korea	UR8	92	1.8	12.2 [11.83,12.57]
Lee	2009	South Korea	UL8	96	1.6	11.9 [11.58,12.22]
Lee	2009	South Korea	LL8	135	1.3	12.2 [11.98,12.42]
Lee	2009	South Korea	LR8	140	1.4	12.3 [12.07,12.53]
Prieto	2004	Spain	UR8			
Prieto	2004	Spain	UL8			
Prieto	2004	Spain	LL8	6	0.69	14.96 [14.41,15.51]
Prieto	2004	Spain	LR8	6	0.63	14.78 [14.28,15.28]
Karatas	2013	Turkey	UR8	120	1.29	11.52 [11.29,11.75]
Karatas	2013	Turkey	UL8	119	1.31	11.55 [11.31,11.79]
Karatas	2013	Turkey	LL8	108	1.21	11.75 [11.52,11.98]
Karatas	2013	Turkey	LR8	102	1.26	11.68 [11.44,11.92]
Karadayi	2014	Turkey	UR8			
Karadayi	2014	Turkey	UL8			
Karadayi	2014	Turkey	LL8	32	1.19	11.8 [11.39,12.21]
Karadayi	2014	Turkey	LR8			
Boonpitaksathit	2011	UK	UR8			
Boonpitaksathit	2011	UK	UL8			
Boonpitaksathit	2011	UK	LL8			
Boonpitaksathit	2011	UK	LR8			

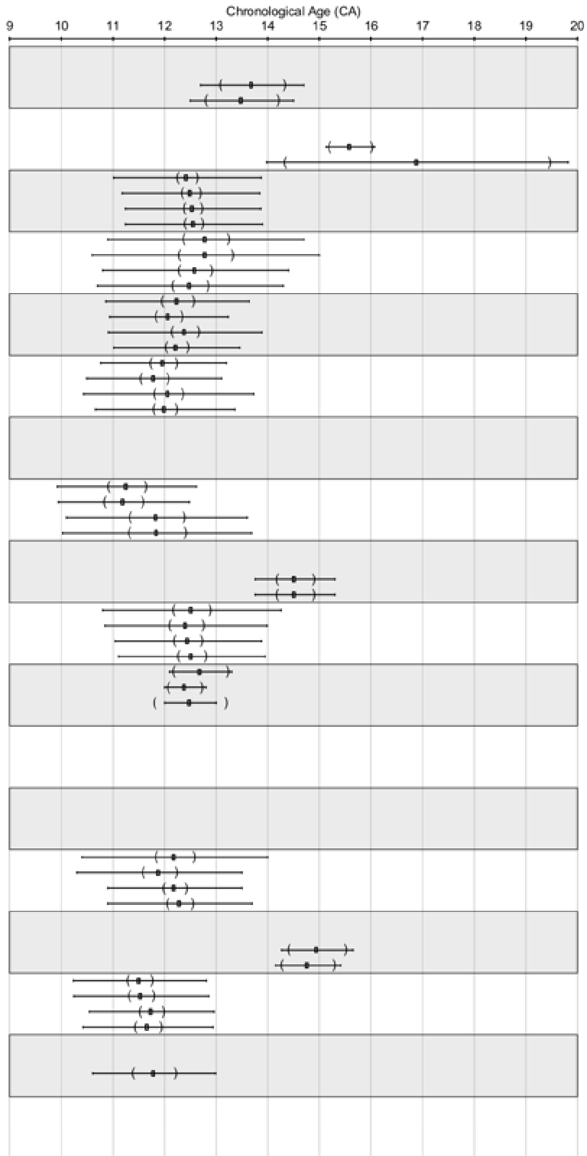


Figure A4: Mean chronological age for boys in Demirjian's development stage D for all four third molars from each of the included studies (if data available from article).

Gender=Male − Stage=D

Study	Year	Country	Tooth	Size	SD	Mean [95% CI]
Meinl	2007	Austria	UR8			
Meinl	2007	Austria	UL8			
Meinl	2007	Austria	LL8	14	2.3	16.1 [14.9,17.3]
Meinl	2007	Austria	LR8	13	1.6	15.3 [14.43,16.17]
Lopez	2013	Brazil	UR8	18	1.58	17.1 [16.37,17.83]
Lopez	2013	Brazil	UL8	15	1.3	17 [16.34,17.66]
Lopez	2013	Brazil	LL8	18	1.22	17.4 [16.84,17.96]
Lopez	2013	Brazil	LR8	8	1.51	17.6 [16.55,18.65]
Zeng	2010	China	UR8	286	1.6	13.64 [13.45,13.83]
Zeng	2010	China	UL8	275	1.62	13.58 [13.39,13.77]
Zeng	2010	China	LL8	212	1.48	13.47 [13.27,13.67]
Zeng	2010	China	LR8	217	1.49	13.52 [13.32,13.72]
Li	2012	China	UR8	159	2.2	13.9 [13.56,14.24]
Li	2012	China	UL8	158	2	13.7 [13.39,14.01]
Li	2012	China	LL8	91	2.3	14.3 [13.83,14.77]
Li	2012	China	LR8	103	2.2	14.2 [13.78,14.62]
Guo	2014	China	UR8	263	1.74	13.12 [12.91,13.33]
Guo	2014	China	UL8	261	1.61	13 [12.8,13.19]
Guo	2014	China	LL8	246	1.35	12.92 [12.75,13.09]
Guo	2014	China	LR8	254	1.41	12.93 [12.75,13.1]
Guo	2015	China	UR8	275	1.65	12.92 [12.72,13.12]
Guo	2015	China	UL8	274	1.7	12.85 [12.65,13.05]
Guo	2015	China	LL8	251	1.39	12.87 [12.7,13.04]
Guo	2015	China	LR8	258	1.45	12.88 [12.7,13.06]
Rouge−Maillart	2011	France	UR8	29	1.06	14.23 [13.84,14.62]
Rouge−Maillart	2011	France	UL8	28	1.08	14.22 [13.82,14.62]
Rouge−Maillart	2011	France	LL8	28	1.05	14.36 [13.97,14.75]
Rouge−Maillart	2011	France	LR8	28	1.06	14.23 [13.84,14.62]
Zandi	2015	Iran	UR8	71	2.32	13.55 [13.01,14.09]
Zandi	2015	Iran	UL8	73	2.58	13.7 [13.11,14.29]
Zandi	2015	Iran	LL8	57	2.22	13.91 [13.33,14.49]
Zandi	2015	Iran	LR8	52	2.21	13.77 [13.17,14.37]
Johan	2012	Malaysia	UR8			
Johan	2012	Malaysia	UL8			
Johan	2012	Malaysia	LL8	47	0.95	14.81 [14.54,15.08]
Johan	2012	Malaysia	LR8	50	0.88	14.72 [14.48,14.96]
Elshehawi	2016	Malta	UR8	122	1.16	13.2 [12.99,13.41]
Elshehawi	2016	Malta	UL8	53	0.86	14.82 [14.59,15.05]
Elshehawi	2016	Malta	LL8	88	1.16	13.89 [13.65,14.13]
Elshehawi	2016	Malta	LR8	98	1.28	13.69 [13.44,13.94]
Olze	2010	Native Canada	UR8	10	2.7	15.1 [13.43,16.77]
Olze	2010	Native Canada	UL8	11	1.8	14.5 [13.44,15.56]
Olze	2010	Native Canada	LL8	3	0.5	13 [12.43,13.57]
Olze	2010	Native Canada	LR8			
Olze	2006	South Africa	UR8	11	1.5	13.2 [12.31,14.09]
Olze	2006	South Africa	UL8	13	1.5	13.4 [12.58,14.22]
Olze	2006	South Africa	LL8	10	1.6	13.4 [12.41,14.39]
Olze	2006	South Africa	LR8	12	4.5	14.8 [12.25,17.35]
Olze	2012	South Africa	UR8	11	1.49	13.21 [12.33,14.09]
Olze	2012	South Africa	UL8	13	1.47	13.39 [12.59,14.19]
Olze	2012	South Africa	LL8			
Olze	2012	South Africa	LR8			
Lee	2009	South Korea	UR8	74	1.7	14.1 [13.71,14.49]
Lee	2009	South Korea	UL8	72	1.6	14 [13.63,14.37]
Lee	2009	South Korea	LL8	83	1.5	14.6 [14.28,14.92]
Lee	2009	South Korea	LR8	82	1.8	14.8 [14.41,15.19]
Prieto	2004	Spain	UR8			
Prieto	2004	Spain	UL8			
Prieto	2004	Spain	LL8	43	1.04	15.08 [14.77,15.39]
Prieto	2004	Spain	LR8	54	0.94	15.05 [14.8,15.3]
Karatas	2013	Turkey	UR8	104	1.35	12.68 [12.42,12.94]
Karatas	2013	Turkey	UL8	101	1.34	12.7 [12.44,12.96]
Karatas	2013	Turkey	LL8	86	1.28	12.89 [12.62,13.16]
Karatas	2013	Turkey	LR8	85	1.26	12.86 [12.59,13.13]
Karadayi	2014	Turkey	UR8			
Karadayi	2014	Turkey	UL8			
Karadayi	2014	Turkey	LL8	40	1.7	14.18 [13.65,14.71]
Karadayi	2014	Turkey	LR8			
Boonpitaksathit	2011	UK	UR8			
Boonpitaksathit	2011	UK	UL8			
Boonpitaksathit	2011	UK	LL8			
Boonpitaksathit	2011	UK	LR8			

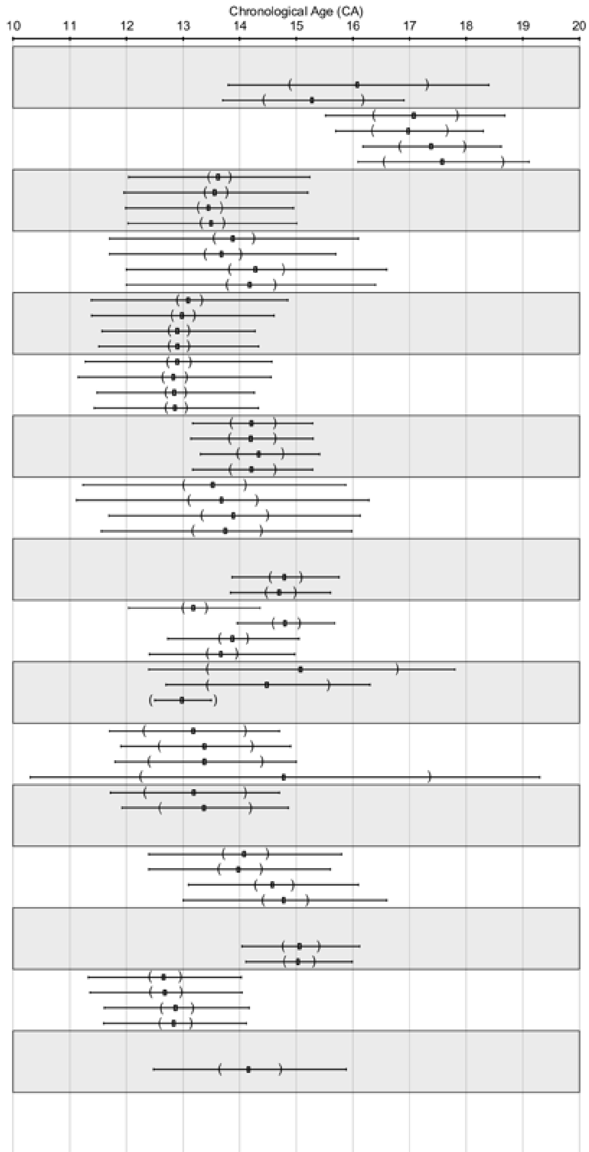


Figure A5: Mean chronological age for boys in Demirjian's development stage E for all four third molars from each of the included studies (if data available from article).

Gender=Male − Stage=E

Study	Year	Country	Tooth	Size	SD	Mean [95% CI]
Meinl	2007	Austria	UR8			
Meinl	2007	Austria	UL8			
Meinl	2007	Austria	LL8	21	1.8	15.6 [14.83,16.37]
Meinl	2007	Austria	LR8	19	1.6	15.1 [14.38,15.82]
Lopez	2013	Brazil	UR8	13	2.55	17.9 [16.51,19.29]
Lopez	2013	Brazil	UL8	20	2.62	17.8 [16.65,18.95]
Lopez	2013	Brazil	LL8	26	2.16	17.3 [16.47,18.13]
Lopez	2013	Brazil	LR8	36	1.75	17.1 [16.53,17.67]
Zeng	2010	China	UR8	92	1.79	15.55 [15.18,15.92]
Zeng	2010	China	UL8	94	1.8	15.64 [15.28,16]
Zeng	2010	China	LL8	117	1.73	15.31 [15,15.62]
Zeng	2010	China	LR8	113	1.59	15.13 [14.84,15.42]
Li	2012	China	UR8	60	2.3	17 [16.42,17.58]
Li	2012	China	UL8	64	2.1	16.6 [16.09,17.11]
Li	2012	China	LL8	65	2	16.5 [16.01,16.99]
Li	2012	China	LR8	66	2.4	16.7 [16.12,17.28]
Guo	2014	China	UR8	96	2.18	15.29 [14.86,15.73]
Guo	2014	China	UL8	97	2.16	15.34 [14.91,15.77]
Guo	2014	China	LL8	159	2.3	15.78 [15.42,16.14]
Guo	2014	China	LR8	159	2.22	15.6 [15.26,15.95]
Guo	2015	China	UR8	96	2.17	15.29 [14.86,15.72]
Guo	2015	China	UL8	97	2.15	15.34 [14.91,15.77]
Guo	2015	China	LL8	159	2.29	15.78 [15.42,16.14]
Guo	2015	China	LR8	159	2.21	15.6 [15.26,15.94]
Rouge−Maillart	2011	France	UR8	24	1.47	15.29 [14.7,15.88]
Rouge−Maillart	2011	France	UL8	26	1.43	15.35 [14.8,15.9]
Rouge−Maillart	2011	France	LL8	24	1.33	15.24 [14.71,15.77]
Rouge−Maillart	2011	France	LR8	22	1.47	15.29 [14.68,15.9]
Zandi	2015	Iran	UR8	41	2.11	15.12 [14.47,15.77]
Zandi	2015	Iran	UL8	39	2.14	15 [14.33,15.67]
Zandi	2015	Iran	LL8	46	2.1	15.35 [14.74,15.96]
Zandi	2015	Iran	LR8	50	1.94	15.22 [14.68,15.76]
Johan	2012	Malaysia	UR8			
Johan	2012	Malaysia	UL8			
Johan	2012	Malaysia	LL8	58	1.14	15.84 [15.55,16.13]
Johan	2012	Malaysia	LR8	53	1.26	15.81 [15.47,16.15]
Elshehawi	2016	Malta	UR8	27	1.07	15.3 [14.9,15.7]
Elshehawi	2016	Malta	UL8	23	0.97	15.69 [15.29,16.09]
Elshehawi	2016	Malta	LL8	46	1.39	14.83 [14.43,15.23]
Elshehawi	2016	Malta	LR8	47	1.61	14.81 [14.35,15.27]
Olze	2010	Native Canada	UR8	31	1.5	15.8 [15.27,16.33]
Olze	2010	Native Canada	UL8	33	1.5	15.8 [15.29,16.31]
Olze	2010	Native Canada	LL8	13	1.3	15.3 [14.59,16.01]
Olze	2010	Native Canada	LR8	14	1.4	15.5 [14.77,16.23]
Olze	2006	South Africa	UR8	15	2.3	15.9 [14.74,17.06]
Olze	2006	South Africa	UL8	14	2.9	16.1 [14.58,17.62]
Olze	2006	South Africa	LL8	15	2.6	15.4 [14.08,16.72]
Olze	2006	South Africa	LR8	13	2.4	15.2 [13.9,16.5]
Olze	2012	South Africa	UR8	14	2.04	15.57 [14.5,16.64]
Olze	2012	South Africa	UL8	11	2.06	14.94 [13.72,16.16]
Olze	2012	South Africa	LL8			
Olze	2012	South Africa	LR8			
Lee	2009	South Korea	UR8	81	1.6	15.8 [15.45,16.15]
Lee	2009	South Korea	UL8	86	1.7	15.9 [15.54,16.26]
Lee	2009	South Korea	LL8	69	1.7	16.2 [15.8,16.6]
Lee	2009	South Korea	LR8	63	1.5	15.8 [15.43,16.17]
Prieto	2004	Spain	UR8			
Prieto	2004	Spain	UL8			
Prieto	2004	Spain	LL8	114	1.03	15.22 [15.03,15.41]
Prieto	2004	Spain	LR8	105	0.91	15.17 [15,15.34]
Karatas	2013	Turkey	UR8	13	1.54	13.81 [12.97,14.65]
Karatas	2013	Turkey	UL8	14	1.8	13.54 [12.6,14.48]
Karatas	2013	Turkey	LL8	10	0.55	14.39 [14.05,14.73]
Karatas	2013	Turkey	LR8	11	0.52	14.37 [14.06,14.68]
Karadayi	2014	Turkey	UR8			
Karadayi	2014	Turkey	UL8			
Karadayi	2014	Turkey	LL8	42	1.98	15.84 [15.24,16.44]
Karadayi	2014	Turkey	LR8			
Boonpitaksathit	2011	UK	UR8	123	1.08	15.09 [14.9,15.28]
Boonpitaksathit	2011	UK	UL8	124	1.1	15.14 [14.95,15.33]
Boonpitaksathit	2011	UK	LL8	137	1.11	15.34 [15.15,15.53]
Boonpitaksathit	2011	UK	LR8	149	1.28	15.4 [15.19,15.61]

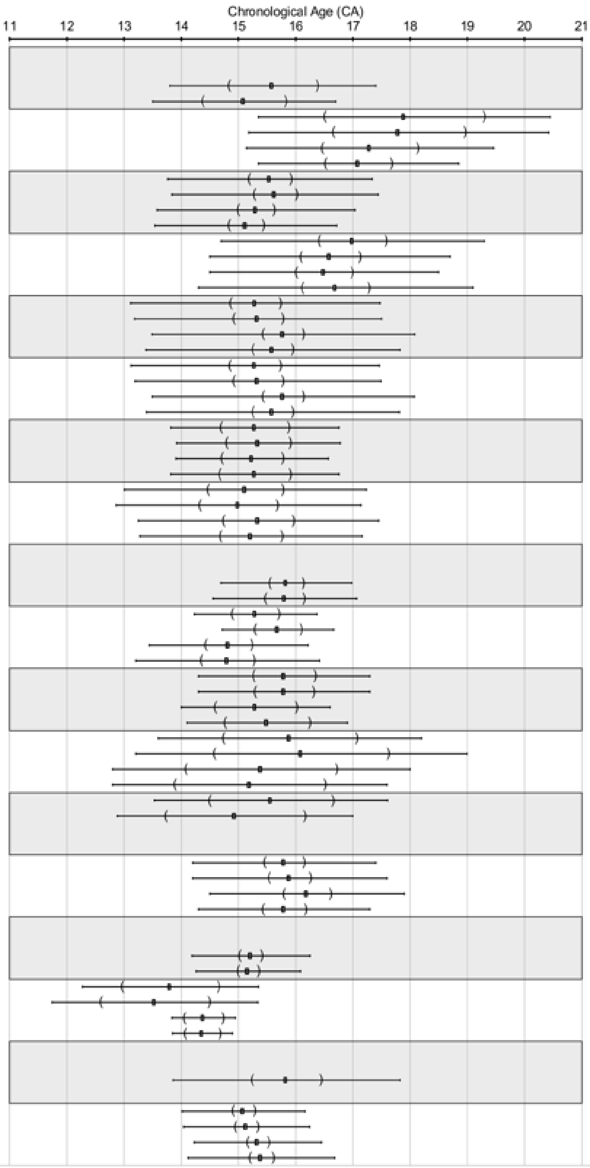


Figure A6: Mean chronological age for boys in Demirjian's development stage F for all four third molars from each of the included studies (if data available from article).

Gender=Male – Stage=F

Study	Year	Country	Tooth	Size	SD	Mean [95% CI]
Meinl	2007	Austria	UR8			
Meinl	2007	Austria	UL8			
Meinl	2007	Austria	LL8	16	2.6	17.5 [16.23,18.77]
Meinl	2007	Austria	LR8	24	2	17.6 [16.8,18.4]
Lopez	2013	Brazil	UR8	58	2.1	18.1 [17.56,18.64]
Lopez	2013	Brazil	UL8	48	1.99	18 [17.44,18.56]
Lopez	2013	Brazil	LL8	33	1.76	17.4 [16.8,18]
Lopez	2013	Brazil	LR8	32	2.06	17.8 [17.09,18.51]
Zeng	2010	China	UR8	71	1.66	17.45 [17.06,17.84]
Zeng	2010	China	UL8	70	1.66	17.47 [17.08,17.86]
Zeng	2010	China	LL8	68	1.62	17.06 [16.67,17.45]
Zeng	2010	China	LR8	71	1.76	17.13 [16.72,17.54]
Li	2012	China	UR8	52	2	18.7 [18.16,19.24]
Li	2012	China	UL8	61	1.9	18.9 [18.42,19.38]
Li	2012	China	LL8	54	2.5	18 [17.33,18.67]
Li	2012	China	LR8	63	2.1	18 [17.48,18.52]
Guo	2014	China	UR8	44	2.41	17.95 [17.24,18.67]
Guo	2014	China	UL8	40	2.61	18.05 [17.24,18.86]
Guo	2014	China	LL8	67	3.08	19.06 [18.32,19.8]
Guo	2014	China	LR8	75	3.05	19.16 [18.47,19.85]
Guo	2015	China	UR8	44	2.38	17.95 [17.25,18.65]
Guo	2015	China	UL8	40	2.57	18.05 [17.25,18.85]
Guo	2015	China	LL8	66	2.96	18.95 [18.24,19.66]
Guo	2015	China	LR8	73	2.84	18.97 [18.32,19.62]
Rouge–Maillart	2011	France	UR8	16	0.84	16.28 [15.87,16.69]
Rouge–Maillart	2011	France	UL8	16	0.96	16.21 [15.74,16.68]
Rouge–Maillart	2011	France	LL8	24	2.08	16.82 [15.99,17.65]
Rouge–Maillart	2011	France	LR8	23	1.44	16.4 [15.81,16.99]
Zandi	2015	Iran	UR8	35	1.38	16.49 [16.03,16.95]
Zandi	2015	Iran	UL8	35	1.97	16.57 [15.92,17.22]
Zandi	2015	Iran	LL8	39	2.46	16.97 [16.2,17.74]
Zandi	2015	Iran	LR8	39	2.44	17.1 [16.33,17.87]
Johan	2012	Malaysia	UR8			
Johan	2012	Malaysia	UL8			
Johan	2012	Malaysia	LL8	59	1.47	17.03 [16.65,17.41]
Johan	2012	Malaysia	LR8	64	1.45	17.2 [16.85,17.55]
Elshehawi	2016	Malta	UR8	18	0.73	15.66 [15.32,16]
Elshehawi	2016	Malta	UL8	35	1.04	16.42 [16.08,16.76]
Elshehawi	2016	Malta	LL8	40	1.19	16.67 [16.3,17.04]
Elshehawi	2016	Malta	LR8	41	1.13	16.66 [16.31,17.01]
Olze	2010	Native Canada	UR8	15	1.8	17.5 [16.59,18.41]
Olze	2010	Native Canada	UL8	17	1.1	17.8 [17.28,18.32]
Olze	2010	Native Canada	LL8	11	1.8	17.4 [16.34,18.46]
Olze	2010	Native Canada	LR8	12	1.6	18.1 [17.19,19.01]
Olze	2006	South Africa	UR8	23	2.3	17.9 [16.96,18.84]
Olze	2006	South Africa	UL8	27	2.4	17.9 [16.99,18.81]
Olze	2006	South Africa	LL8	51	2.5	18.6 [17.91,19.29]
Olze	2006	South Africa	LR8	50	2.3	18.7 [18.06,19.34]
Olze	2012	South Africa	UR8	22	2.34	17.86 [16.88,18.84]
Olze	2012	South Africa	UL8	26	2.43	17.92 [16.99,18.85]
Olze	2012	South Africa	LL8	20	2.35	18.43 [17.4,19.46]
Olze	2012	South Africa	LR8	19	2.54	18.48 [17.34,19.62]
Lee	2009	South Korea	UR8	80	1.5	16.7 [16.37,17.03]
Lee	2009	South Korea	UL8	82	1.4	16.8 [16.5,17.1]
Lee	2009	South Korea	LL8	99	1.4	16.7 [16.42,16.98]
Lee	2009	South Korea	LR8	113	1.5	16.9 [16.62,17.18]
Prieto	2004	Spain	UR8			
Prieto	2004	Spain	UL8			
Prieto	2004	Spain	LL8	177	1.34	16.42 [16.22,16.62]
Prieto	2004	Spain	LR8	182	1.33	16.44 [16.25,16.63]
Karatas	2013	Turkey	UR8	3	0	15
Karatas	2013	Turkey	UL8	3	0	15
Karatas	2013	Turkey	LL8	3	0	15
Karatas	2013	Turkey	LR8	3	0	15
Karadayi	2014	Turkey	UR8			
Karadayi	2014	Turkey	UL8			
Karadayi	2014	Turkey	LL8	46	1.65	17.01 [16.53,17.49]
Karadayi	2014	Turkey	LR8			
Boonpitaksathit	2011	UK	UR8	81	0.63	15.33 [15.19,15.47]
Boonpitaksathit	2011	UK	UL8	131	1	16.01 [15.84,16.18]
Boonpitaksathit	2011	UK	LL8	131	1.09	16.53 [16.34,16.72]
Boonpitaksathit	2011	UK	LR8	129	1.08	16.42 [16.23,16.61]

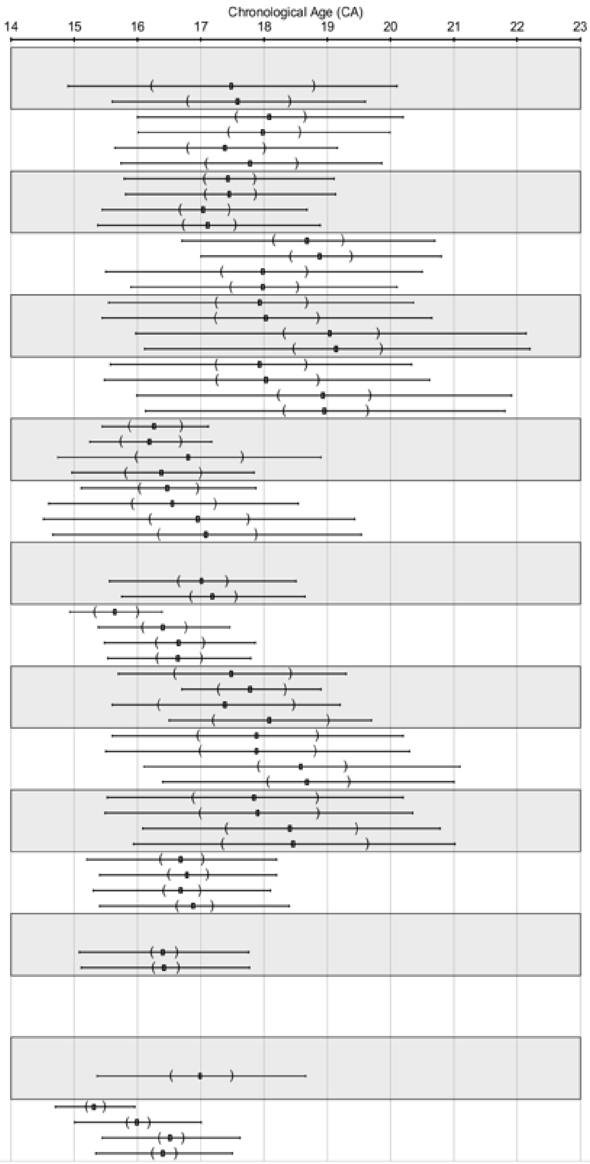


Figure A7: Mean chronological age for boys in Demirjian's development stage G for all four third molars from each of the included studies (if data available from article).

Gender=Male − Stage=G

Study	Year	Country	Tooth	Size	SD	Mean [95% CI]
Meinl	2007	Austria	UR8			
Meinl	2007	Austria	UL8			
Meinl	2007	Austria	LL8	56	2.1	20.1 [19.55,20.65]
Meinl	2007	Austria	LR8	51	1.9	20.1 [19.58,20.62]
Lopez	2013	Brazil	UR8	51	2.2	18.5 [17.9,19.1]
Lopez	2013	Brazil	UL8	61	2.08	18.7 [18.18,19.22]
Lopez	2013	Brazil	LL8	65	1.98	18.7 [18.22,19.18]
Lopez	2013	Brazil	LR8	61	1.9	18.5 [18.02,18.98]
Zeng	2010	China	UR8	103	1.98	19.9 [19.52,20.28]
Zeng	2010	China	UL8	104	2.01	19.93 [19.54,20.32]
Zeng	2010	China	LL8	110	1.79	19.32 [18.99,19.65]
Zeng	2010	China	LR8	111	1.84	19.28 [18.94,19.62]
Li	2012	China	UR8	75	2.2	19.7 [19.2,20.2]
Li	2012	China	UL8	60	2.4	19.9 [19.29,20.51]
Li	2012	China	LL8	115	2.2	19.2 [18.8,19.6]
Li	2012	China	LR8	108	2.3	19.4 [18.97,19.83]
Guo	2014	China	UR8	22	2.95	20.73 [19.49,21.96]
Guo	2014	China	UL8	27	2.54	20.11 [19.15,21.07]
Guo	2014	China	LL8	96	3.04	20.49 [19.88,21.1]
Guo	2014	China	LR8	81	2.88	20.16 [19.54,20.79]
Guo	2015	China	UR8	20	2.76	20.5 [19.29,21.71]
Guo	2015	China	UL8	24	1.93	19.63 [18.86,20.4]
Guo	2015	China	LL8	88	2.7	20.06 [19.5,20.62]
Guo	2015	China	LR8	75	2.63	19.85 [19.25,20.45]
Rouge−Maillart	2011	France	UR8	16	1.07	17.99 [17.47,18.51]
Rouge−Maillart	2011	France	UL8	17	1.8	18.34 [17.48,19.2]
Rouge−Maillart	2011	France	LL8	17	1.67	17.84 [17.05,18.63]
Rouge−Maillart	2011	France	LR8	16	1.13	17.99 [17.44,18.54]
Zandi	2015	Iran	UR8	40	2.43	18.08 [17.33,18.83]
Zandi	2015	Iran	UL8	41	2.4	18.1 [17.37,18.83]
Zandi	2015	Iran	LL8	37	1.85	18.05 [17.45,18.65]
Zandi	2015	Iran	LR8	42	1.88	18.21 [17.64,18.78]
Johan	2012	Malaysia	UR8			
Johan	2012	Malaysia	UL8			
Johan	2012	Malaysia	LL8	105	2.03	19.03 [18.64,19.42]
Johan	2012	Malaysia	LR8	114	2.03	19.16 [18.79,19.53]
Elshehawi	2016	Malta	UR8	23	0.7	18.53 [18.24,18.82]
Elshehawi	2016	Malta	UL8	36	0.93	19.18 [18.88,19.48]
Elshehawi	2016	Malta	LL8	43	0.98	19.01 [18.72,19.3]
Elshehawi	2016	Malta	LR8	46	0.95	19.27 [19,19.54]
Olze	2010	Native Canada	UR8	31	2.3	19.8 [18.99,20.61]
Olze	2010	Native Canada	UL8	26	2	19.4 [18.63,20.17]
Olze	2010	Native Canada	LL8	7	1.3	19.8 [18.84,20.76]
Olze	2010	Native Canada	LR8	7	0.9	19.2 [18.53,19.87]
Olze	2006	South Africa	UR8	48	2.6	20.9 [20.16,21.64]
Olze	2006	South Africa	UL8	47	2.5	20.6 [19.89,21.31]
Olze	2006	South Africa	LL8	49	2.2	21.1 [20.48,21.72]
Olze	2006	South Africa	LR8	60	2.5	21.1 [20.47,21.73]
Olze	2012	South Africa	UR8	45	2.62	20.95 [20.18,21.72]
Olze	2012	South Africa	UL8	42	2.59	20.49 [19.71,21.27]
Olze	2012	South Africa	LL8	23	2.1	20.73 [19.87,21.59]
Olze	2012	South Africa	LR8	30	2.17	20.25 [19.47,21.03]
Lee	2009	South Korea	UR8	73	1.6	18.2 [17.83,18.57]
Lee	2009	South Korea	UL8	72	1.5	18.3 [17.95,18.65]
Lee	2009	South Korea	LL8	90	1.6	18.6 [18.27,18.93]
Lee	2009	South Korea	LR8	79	1.6	18.7 [18.35,19.05]
Prieto	2004	Spain	UR8			
Prieto	2004	Spain	UL8			
Prieto	2004	Spain	LL8	76	1.5	17.92 [17.58,18.26]
Prieto	2004	Spain	LR8	70	1.48	17.67 [17.32,18.02]
Karatas	2013	Turkey	UR8			
Karatas	2013	Turkey	UL8			
Karatas	2013	Turkey	LL8			
Karatas	2013	Turkey	LR8			
Karadayi	2014	Turkey	UR8			
Karadayi	2014	Turkey	UL8			
Karadayi	2014	Turkey	LL8	41	2.04	19.14 [18.52,19.76]
Karadayi	2014	Turkey	LR8			
Boonpitaksathit	2011	UK	UR8	92	0.95	17.24 [17.05,17.43]
Boonpitaksathit	2011	UK	UL8	87	0.96	17.2 [17,17.4]
Boonpitaksathit	2011	UK	LL8	71	1.15	17.56 [17.29,17.83]
Boonpitaksathit	2011	UK	LR8	69	1.19	17.71 [17.43,17.99]

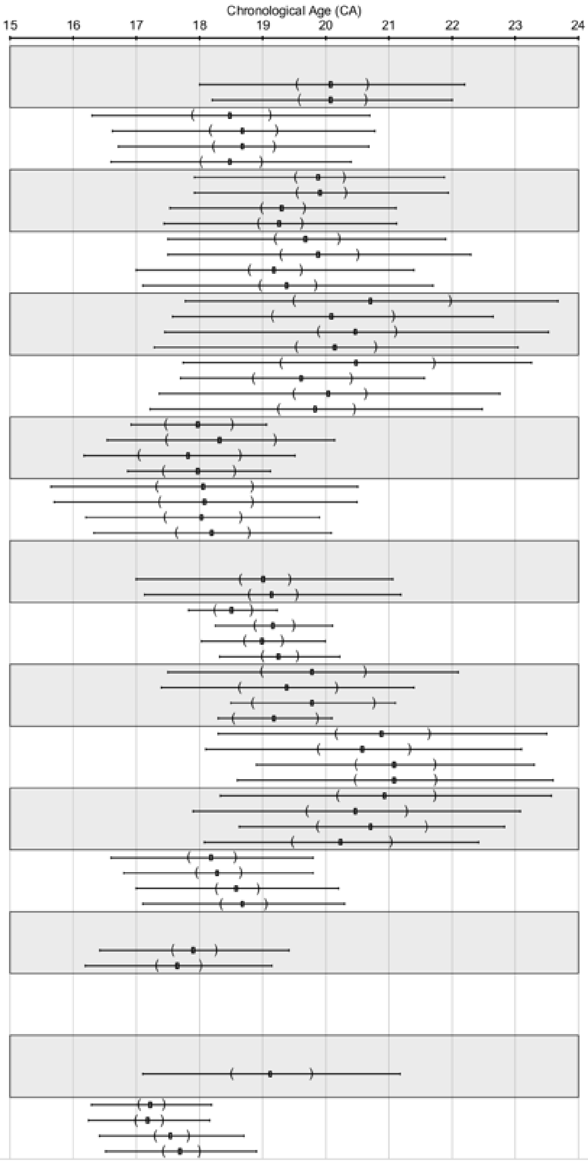
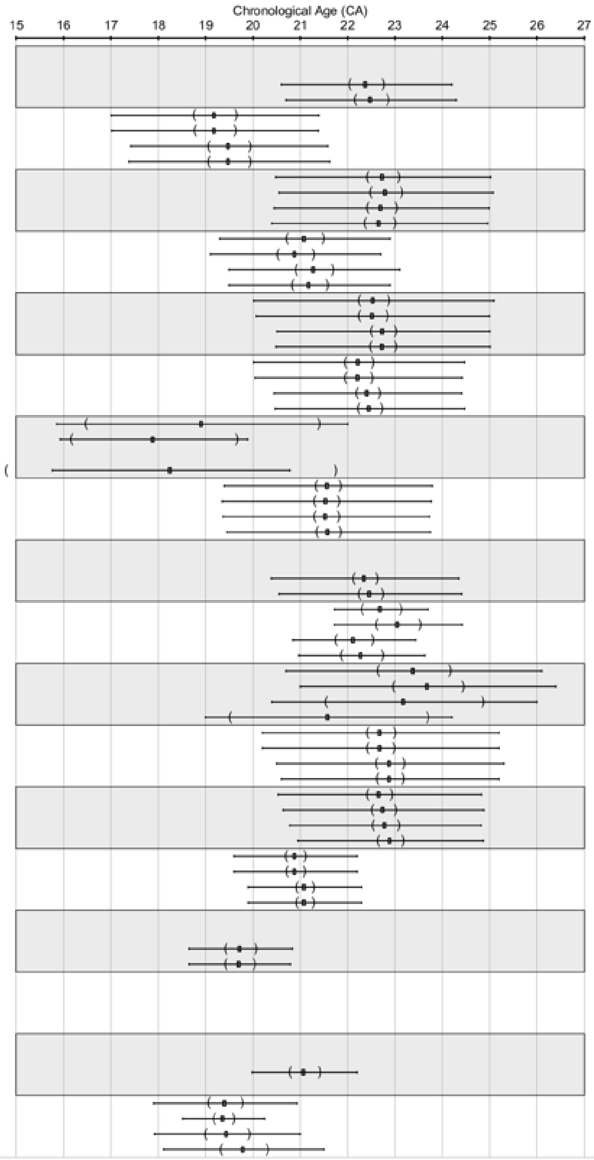


Figure A8: Mean chronological age for boys in Demirjian's development stage H for all four third molars from each of the included studies (if data available from article).

Gender=Male − Stage=H

Study	Year	Country	Tooth	Size	SD	Mean [95% CI]
Meinl	2007	Austria	UR8			
Meinl	2007	Austria	UL8			
Meinl	2007	Austria	LL8	105	1.8	22.4 [22.06,22.74]
Meinl	2007	Austria	LR8	105	1.8	22.5 [22.16,22.84]
Lopez	2013	Brazil	UR8	99	2.19	19.2 [18.77,19.63]
Lopez	2013	Brazil	UL8	101	2.18	19.2 [18.77,19.63]
Lopez	2013	Brazil	LL8	89	2.08	19.5 [19.07,19.93]
Lopez	2013	Brazil	LR8	94	2.12	19.5 [19.07,19.93]
Zeng	2010	China	UR8	192	2.27	22.75 [22.43,23.07]
Zeng	2010	China	UL8	192	2.26	22.81 [22.49,23.13]
Zeng	2010	China	LL8	213	2.27	22.72 [22.42,23.02]
Zeng	2010	China	LR8	218	2.28	22.68 [22.38,22.98]
Li	2012	China	UR8	86	1.8	21.1 [20.72,21.48]
Li	2012	China	UL8	92	1.8	20.9 [20.53,21.27]
Li	2012	China	LL8	86	1.8	21.3 [20.92,21.68]
Li	2012	China	LR8	84	1.7	21.2 [20.84,21.56]
Guo	2014	China	UR8	274	2.54	22.55 [22.25,22.85]
Guo	2014	China	UL8	281	2.46	22.53 [22.25,22.82]
Guo	2014	China	LL8	304	2.25	22.76 [22.5,23.01]
Guo	2014	China	LR8	307	2.26	22.75 [22.49,23]
Guo	2015	China	UR8	241	2.23	22.24 [21.96,22.52]
Guo	2015	China	UL8	252	2.19	22.23 [21.96,22.5]
Guo	2015	China	LL8	269	1.98	22.43 [22.19,22.67]
Guo	2015	China	LR8	277	2	22.47 [22.23,22.71]
Rouge−Maillart	2011	France	UR8	6	3.07	18.93 [16.47,21.39]
Rouge−Maillart	2011	France	UL8	5	1.98	17.91 [16.17,19.65]
Rouge−Maillart	2011	France	LL8	1	0	16.5
Rouge−Maillart	2011	France	LR8	2	2.51	18.27 [14.79,21.75]
Zandi	2015	Iran	UR8	292	2.2	21.59 [21.34,21.84]
Zandi	2015	Iran	UL8	293	2.21	21.56 [21.31,21.81]
Zandi	2015	Iran	LL8	287	2.18	21.55 [21.3,21.8]
Zandi	2015	Iran	LR8	296	2.15	21.6 [21.36,21.84]
Johan	2012	Malaysia	UR8			
Johan	2012	Malaysia	UL8			
Johan	2012	Malaysia	LL8	252	1.98	22.37 [22.13,22.61]
Johan	2012	Malaysia	LR8	240	1.93	22.48 [22.24,22.72]
Elshehawi	2016	Malta	UR8	23	0.99	22.71 [22.31,23.11]
Elshehawi	2016	Malta	UL8	33	1.35	23.07 [22.61,23.53]
Elshehawi	2016	Malta	LL8	44	1.3	22.14 [21.76,22.52]
Elshehawi	2016	Malta	LR8	38	1.33	22.3 [21.88,22.72]
Olze	2010	Native Canada	UR8	50	2.7	23.4 [22.65,24.15]
Olze	2010	Native Canada	UL8	52	2.7	23.7 [22.97,24.43]
Olze	2010	Native Canada	LL8	11	2.8	23.2 [21.55,24.85]
Olze	2010	Native Canada	LR8	6	2.6	21.6 [19.52,23.68]
Olze	2006	South Africa	UR8	301	2.5	22.7 [22.42,22.98]
Olze	2006	South Africa	UL8	305	2.5	22.7 [22.42,22.98]
Olze	2006	South Africa	LL8	272	2.4	22.9 [22.61,23.19]
Olze	2006	South Africa	LR8	277	2.3	22.9 [22.63,23.17]
Olze	2012	South Africa	UR8	282	2.15	22.68 [22.43,22.93]
Olze	2012	South Africa	UL8	288	2.12	22.76 [22.52,23]
Olze	2012	South Africa	LL8	217	2.02	22.8 [22.53,23.07]
Olze	2012	South Africa	LR8	225	1.96	22.91 [22.65,23.17]
Lee	2009	South Korea	UR8	184	1.3	20.9 [20.71,21.09]
Lee	2009	South Korea	UL8	190	1.3	20.9 [20.72,21.08]
Lee	2009	South Korea	LL8	187	1.2	21.1 [20.93,21.27]
Lee	2009	South Korea	LR8	186	1.2	21.1 [20.93,21.27]
Prieto	2004	Spain	UR8			
Prieto	2004	Spain	UL8			
Prieto	2004	Spain	LL8	46	1.09	19.74 [19.43,20.05]
Prieto	2004	Spain	LR8	48	1.07	19.72 [19.42,20.02]
Karatas	2013	Turkey	UR8			
Karatas	2013	Turkey	UL8			
Karatas	2013	Turkey	LL8			
Karatas	2013	Turkey	LR8			
Karadayi	2014	Turkey	UR8			
Karadayi	2014	Turkey	UL8			
Karadayi	2014	Turkey	LL8	49	1.11	21.09 [20.78,21.4]
Karadayi	2014	Turkey	LR8			
Boonpitaksathit	2011	UK	UR8	72	1.52	19.42 [19.07,19.77]
Boonpitaksathit	2011	UK	UL8	68	0.86	19.38 [19.17,19.59]
Boonpitaksathit	2011	UK	LL8	45	1.54	19.46 [19.01,19.91]
Boonpitaksathit	2011	UK	LR8	47	1.69	19.81 [19.33,20.29]



Mean chronological age for girls in Demirjian's development stages A-H

In figures A1-A8, the point estimates are the mean; the horizontal lines show ± 1 standard deviation and the parenthesises the upper and lower 95% confidence interval of the mean.

SD: Standard deviation; CI: Confidence interval of the mean difference; UR8 (18): Upper right third molar; UL8 (28): Upper left third molar; LL8 (38): Lower left third molar; LR8 (48): Lower right third molar.

Figure A9: Mean chronological age for girls in Demirjian's development stage A for all four third molars from each of the included studies (if data available from article).

Gender=Female − Stage=A

Study	Year	Country	Tooth	Size	SD	Mean [95% CI]
Meinl	2007	Austria	UR8			
Meinl	2007	Austria	UL8			
Meinl	2007	Austria	LL8	1	0	12.6
Meinl	2007	Austria	LR8	3	0.5	12.3 [11.73,12.87]
Lopez	2013	Brazil	UR8			
Lopez	2013	Brazil	UL8			
Lopez	2013	Brazil	LL8			
Lopez	2013	Brazil	LR8			
Zeng	2010	China	UR8	13	1.84	10.12 [9.12,11.12]
Zeng	2010	China	UL8	11	1.65	10.21 [9.23,11.19]
Zeng	2010	China	LL8	51	1.82	10.55 [10.05,11.05]
Zeng	2010	China	LR8	46	1.89	10.25 [9.7,10.8]
Li	2012	China	UR8	20	2.5	10.7 [9.6,11.8]
Li	2012	China	UL8	25	2.3	10.4 [9.5,11.3]
Li	2012	China	LL8	25	1.7	10.3 [9.63,10.97]
Li	2012	China	LR8	36	1.5	10 [9.51,10.49]
Guo	2014	China	UR8			
Guo	2014	China	UL8			
Guo	2014	China	LL8			
Guo	2014	China	LR8			
Guo	2015	China	UR8	13	1.57	9.85 [9,10.7]
Guo	2015	China	UL8	11	1.75	10.45 [9.42,11.48]
Guo	2015	China	LL8	40	1.41	10.45 [10.01,10.89]
Guo	2015	China	LR8	45	1.59	10.42 [9.96,10.88]
Rouge−Maillart	2011	France	UR8			
Rouge−Maillart	2011	France	UL8			
Rouge−Maillart	2011	France	LL8			
Rouge−Maillart	2011	France	LR8			
Zandi	2015	Iran	UR8	46	1.46	9.37 [8.95,9.79]
Zandi	2015	Iran	UL8	43	1.56	9.42 [8.95,9.89]
Zandi	2015	Iran	LL8	68	1.39	9.47 [9.14,9.8]
Zandi	2015	Iran	LR8	83	1.31	9.55 [9.27,9.83]
Johan	2012	Malaysia	UR8			
Johan	2012	Malaysia	UL8			
Johan	2012	Malaysia	LL8			
Johan	2012	Malaysia	LR8			
Elshehawi	2016	Malta	UR8	3	0.7	10.06 [9.27,10.85]
Elshehawi	2016	Malta	UL8	3	0.44	9.3 [8.8,9.8]
Elshehawi	2016	Malta	LL8	23	1.48	10.97 [10.37,11.57]
Elshehawi	2016	Malta	LR8	20	1.15	10.91 [10.41,11.41]
Olze	2010	Native Canada	UR8			
Olze	2010	Native Canada	UL8			
Olze	2010	Native Canada	LL8			
Olze	2010	Native Canada	LR8			
Olze	2006	South Africa	UR8			
Olze	2006	South Africa	UL8			
Olze	2006	South Africa	LL8			
Olze	2006	South Africa	LR8			
Olze	2012	South Africa	UR8			
Olze	2012	South Africa	UL8			
Olze	2012	South Africa	LL8			
Olze	2012	South Africa	LR8			
Lee	2009	South Korea	UR8	59	1.3	9.7 [9.37,10.03]
Lee	2009	South Korea	UL8	65	1.3	9.7 [9.38,10.02]
Lee	2009	South Korea	LL8	73	1.6	10.1 [9.73,10.47]
Lee	2009	South Korea	LR8	78	1.7	10.3 [9.92,10.68]
Prieto	2004	Spain	UR8			
Prieto	2004	Spain	UL8			
Prieto	2004	Spain	LL8			
Prieto	2004	Spain	LR8			
Karatas	2013	Turkey	UR8	91	1.36	8.95 [8.67,9.23]
Karatas	2013	Turkey	UL8	98	1.33	9.02 [8.76,9.28]
Karatas	2013	Turkey	LL8	124	1.46	9.3 [9.04,9.56]
Karatas	2013	Turkey	LR8	129	1.43	9.31 [9.06,9.56]
Karadayi	2014	Turkey	UR8			
Karadayi	2014	Turkey	UL8			
Karadayi	2014	Turkey	LL8	28	0.95	9.34 [8.99,9.69]
Karadayi	2014	Turkey	LR8			
Boonpitaksathit	2011	UK	UR8			
Boonpitaksathit	2011	UK	UL8			
Boonpitaksathit	2011	UK	LL8			
Boonpitaksathit	2011	UK	LR8			

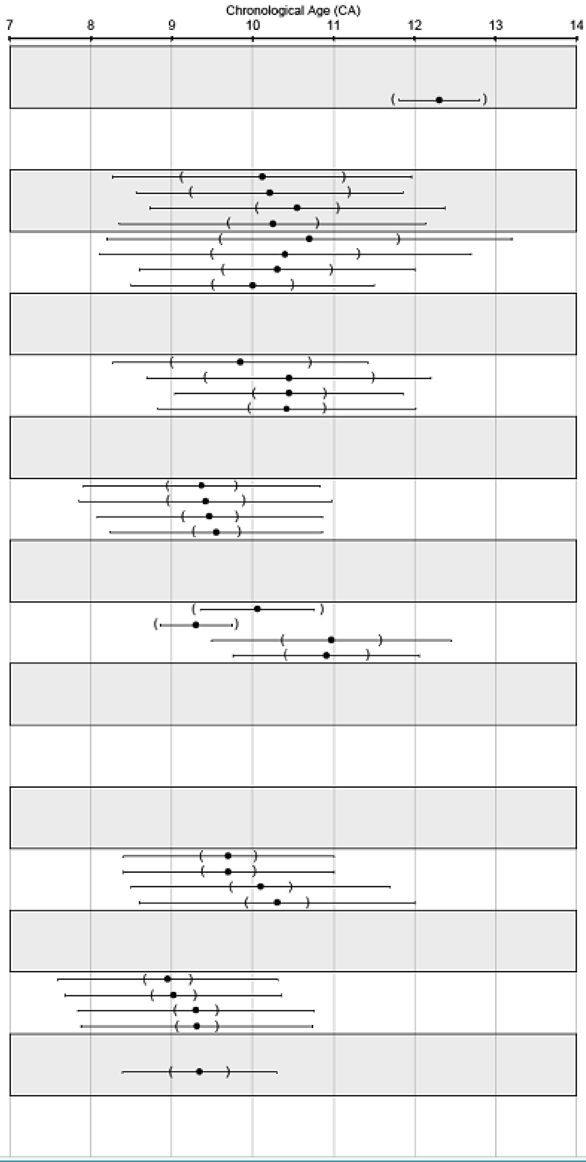


Figure A10: Mean chronological age for girls in Demirjian's development stage B for all four third molars from each of the included studies (if data available from article).

Gender=Female − Stage=B

Study	Year	Country	Tooth	Size	SD	Mean [95% CI]
Meinl	2007	Austria	UR8			
Meinl	2007	Austria	UL8			
Meinl	2007	Austria	LL8	5	0.3	12.3 [12.04,12.56]
Meinl	2007	Austria	LR8	3	0.4	12.4 [11.95,12.85]
Lopez	2013	Brazil	UR8			
Lopez	2013	Brazil	UL8			
Lopez	2013	Brazil	LL8	1	0	15.7
Lopez	2013	Brazil	LR8			
Zeng	2010	China	UR8	61	1.41	11.14 [10.79,11.49]
Zeng	2010	China	UL8	69	1.42	11.2 [10.86,11.54]
Zeng	2010	China	LL8	113	1.37	11.02 [10.77,11.27]
Zeng	2010	China	LR8	104	1.25	11.05 [10.81,11.29]
Li	2012	China	UR8	33	2.5	10.2 [9.35,11.05]
Li	2012	China	UL8	33	1.8	11.1 [10.49,11.71]
Li	2012	China	LL8	50	1.4	10.8 [10.41,11.19]
Li	2012	China	LR8	49	1.5	10.7 [10.28,11.12]
Guo	2014	China	UR8			
Guo	2014	China	UL8			
Guo	2014	China	LL8			
Guo	2014	China	LR8			
Guo	2015	China	UR8	27	1.53	11.22 [10.64,11.8]
Guo	2015	China	UL8	24	1.21	10.62 [10.14,11.1]
Guo	2015	China	LL8	23	1.27	11.17 [10.65,11.69]
Guo	2015	China	LR8	19	1.35	11.47 [10.86,12.08]
Rouge−Maillart	2011	France	UR8			
Rouge−Maillart	2011	France	UL8			
Rouge−Maillart	2011	France	LL8			
Rouge−Maillart	2011	France	LR8			
Zandi	2015	Iran	UR8	67	1.54	10.04 [9.67,10.41]
Zandi	2015	Iran	UL8	74	1.47	9.85 [9.52,10.18]
Zandi	2015	Iran	LL8	102	1.42	10.11 [9.83,10.39]
Zandi	2015	Iran	LR8	97	1.36	10.06 [9.79,10.33]
Johan	2012	Malaysia	UR8			
Johan	2012	Malaysia	UL8			
Johan	2012	Malaysia	LL8			
Johan	2012	Malaysia	LR8			
Elshehawi	2016	Malta	UR8	62	1.43	11.12 [10.76,11.48]
Elshehawi	2016	Malta	UL8	60	1.4	10.82 [10.47,11.17]
Elshehawi	2016	Malta	LL8	73	1.32	11.16 [10.86,11.46]
Elshehawi	2016	Malta	LR8	77	1.38	11.18 [10.87,11.49]
Olze	2010	Native Canada	UR8			
Olze	2010	Native Canada	UL8			
Olze	2010	Native Canada	LL8			
Olze	2010	Native Canada	LR8			
Olze	2006	South Africa	UR8			
Olze	2006	South Africa	UL8			
Olze	2006	South Africa	LL8			
Olze	2006	South Africa	LR8			
Olze	2012	South Africa	UR8			
Olze	2012	South Africa	UL8			
Olze	2012	South Africa	LL8			
Olze	2012	South Africa	LR8			
Lee	2009	South Korea	UR8	49	1.2	10.7 [10.36,11.04]
Lee	2009	South Korea	UL8	50	1.3	10.8 [10.44,11.16]
Lee	2009	South Korea	LL8	50	1.2	11 [10.67,11.33]
Lee	2009	South Korea	LR8	45	1	10.7 [10.41,10.99]
Prieto	2004	Spain	UR8			
Prieto	2004	Spain	UL8			
Prieto	2004	Spain	LL8			
Prieto	2004	Spain	LR8			
Karatas	2013	Turkey	UR8	128	1.22	10.31 [10.1,10.52]
Karatas	2013	Turkey	UL8	124	1.28	10.38 [10.15,10.61]
Karatas	2013	Turkey	LL8	130	1.31	10.57 [10.34,10.8]
Karatas	2013	Turkey	LR8	132	1.34	10.69 [10.46,10.92]
Karadayi	2014	Turkey	UR8			
Karadayi	2014	Turkey	UL8			
Karadayi	2014	Turkey	LL8	32	1.42	10.71 [10.22,11.2]
Karadayi	2014	Turkey	LR8			
Boonpitaksathit	2011	UK	UR8			
Boonpitaksathit	2011	UK	UL8			
Boonpitaksathit	2011	UK	LL8			
Boonpitaksathit	2011	UK	LR8			

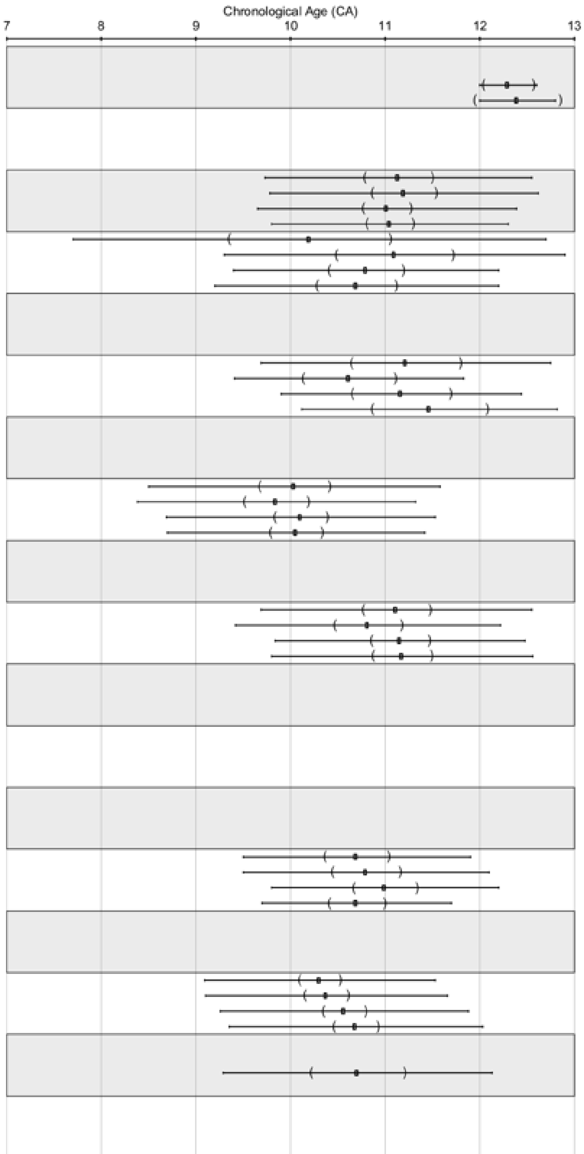


Figure A11: Mean chronological age for girls in Demirjian's development stage C for all four third molars from each of the included studies (if data available from article).

Gender=Female – Stage=C

Study	Year	Country	Tooth	Size	SD	Mean [95% CI]
Meinl	2007	Austria	UR8			
Meinl	2007	Austria	UL8			
Meinl	2007	Austria	LL8	14	1.6	14.6 [13.76,15.44]
Meinl	2007	Austria	LR8	9	1.3	13.8 [12.95,14.65]
Lopez	2013	Brazil	UR8	1	0	18.2
Lopez	2013	Brazil	UL8	2	1.48	21 [18.95,23.05]
Lopez	2013	Brazil	LL8	9	1.95	16.5 [15.23,17.77]
Lopez	2013	Brazil	LR8	9	2.37	16.8 [15.25,18.35]
Zeng	2010	China	UR8	333	1.53	12.41 [12.25,12.57]
Zeng	2010	China	UL8	335	1.48	12.42 [12.26,12.58]
Zeng	2010	China	LL8	385	1.5	12.67 [12.52,12.82]
Zeng	2010	China	LR8	376	1.48	12.61 [12.46,12.76]
Li	2012	China	UR8	87	2	12.4 [11.98,12.82]
Li	2012	China	UL8	88	2.2	12.4 [11.94,12.86]
Li	2012	China	LL8	145	2.2	12.5 [12.14,12.86]
Li	2012	China	LR8	138	2.1	12.4 [12.05,12.75]
Guo	2014	China	UR8	97	1.27	12.2 [11.95,12.45]
Guo	2014	China	UL8	91	1.08	12.15 [11.93,12.37]
Guo	2014	China	LL8	135	1.32	12.15 [11.92,12.37]
Guo	2014	China	LR8	164	1.46	12.39 [12.17,12.61]
Guo	2015	China	UR8	98	1.35	11.77 [11.5,12.04]
Guo	2015	China	UL8	89	1.3	11.73 [11.46,12]
Guo	2015	China	LL8	129	1.13	11.78 [11.59,11.97]
Guo	2015	China	LR8	150	1.35	11.97 [11.75,12.19]
Rouge−Maillart	2011	France	UR8			
Rouge−Maillart	2011	France	UL8			
Rouge−Maillart	2011	France	LL8			
Rouge−Maillart	2011	France	LR8			
Zandi	2015	Iran	UR8	68	1.42	11.22 [10.88,11.56]
Zandi	2015	Iran	UL8	71	1.34	11.25 [10.94,11.56]
Zandi	2015	Iran	LL8	82	1.27	12.06 [11.79,12.33]
Zandi	2015	Iran	LR8	83	1.31	12.01 [11.73,12.29]
Johan	2012	Malaysia	UR8			
Johan	2012	Malaysia	UL8			
Johan	2012	Malaysia	LL8	20	0.69	14.55 [14.25,14.85]
Johan	2012	Malaysia	LR8	24	0.72	14.58 [14.29,14.87]
Elshehawi	2016	Malta	UR8	109	1.64	12.65 [12.34,12.96]
Elshehawi	2016	Malta	UL8	102	1.65	12.62 [12.3,12.94]
Elshehawi	2016	Malta	LL8	101	1.32	12.94 [12.68,13.2]
Elshehawi	2016	Malta	LR8	99	1.3	12.85 [12.59,13.11]
Olze	2010	Native Canada	UR8	9	1.4	12.6 [11.69,13.51]
Olze	2010	Native Canada	UL8	8	1.2	12.3 [11.47,13.13]
Olze	2010	Native Canada	LL8	5	0.5	11.7 [11.26,12.14]
Olze	2010	Native Canada	LR8	5	0.5	11.7 [11.26,12.14]
Olze	2006	South Africa	UR8			
Olze	2006	South Africa	UL8			
Olze	2006	South Africa	LL8			
Olze	2006	South Africa	LR8			
Olze	2012	South Africa	UR8			
Olze	2012	South Africa	UL8			
Olze	2012	South Africa	LL8			
Olze	2012	South Africa	LR8			
Lee	2009	South Korea	UR8	95	1.5	12.5 [12.2,12.8]
Lee	2009	South Korea	UL8	103	1.4	12.4 [12.13,12.67]
Lee	2009	South Korea	LL8	137	1.5	12.6 [12.35,12.85]
Lee	2009	South Korea	LR8	130	1.5	12.6 [12.34,12.86]
Prieto	2004	Spain	UR8			
Prieto	2004	Spain	UL8			
Prieto	2004	Spain	LL8	11	1.33	14.99 [14.2,15.78]
Prieto	2004	Spain	LR8	14	1.19	14.92 [14.3,15.54]
Karatas	2013	Turkey	UR8	115	1.26	11.56 [11.33,11.79]
Karatas	2013	Turkey	UL8	116	1.29	11.57 [11.34,11.8]
Karatas	2013	Turkey	LL8	97	1.28	11.78 [11.53,12.03]
Karatas	2013	Turkey	LR8	93	1.32	11.88 [11.61,12.15]
Karadayi	2014	Turkey	UR8			
Karadayi	2014	Turkey	UL8			
Karadayi	2014	Turkey	LL8	35	1.39	11.78 [11.32,12.24]
Karadayi	2014	Turkey	LR8			
Boonpitaksathit	2011	UK	UR8			
Boonpitaksathit	2011	UK	UL8			
Boonpitaksathit	2011	UK	LL8			
Boonpitaksathit	2011	UK	LR8			

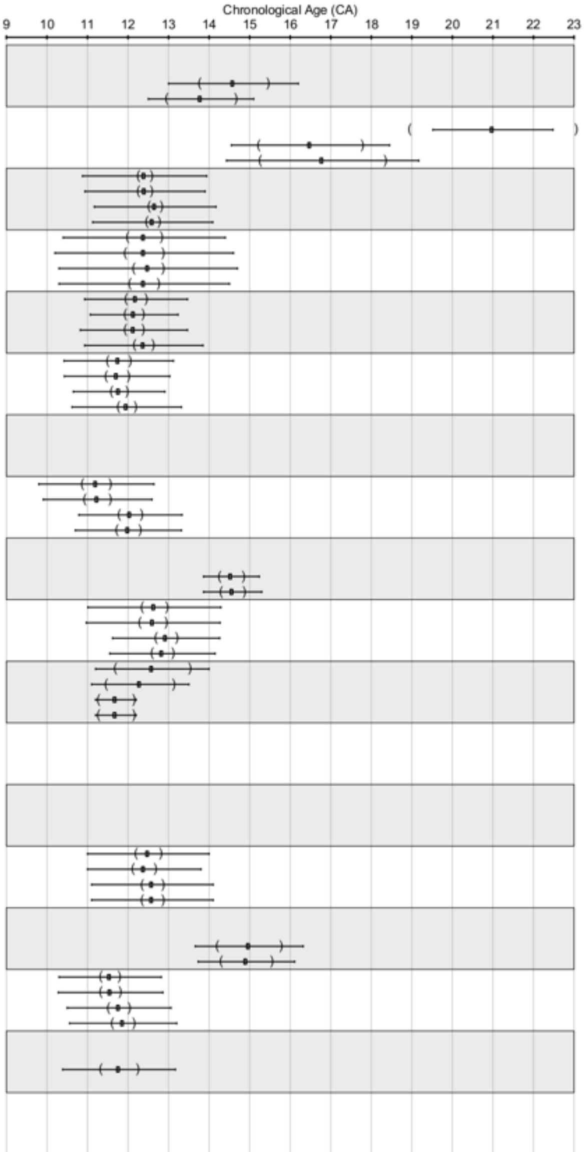


Figure A12: Mean chronological age for girls in Demirjian's development stage D for all four third molars from each of the included studies (if data available from article).

Gender=Female − Stage=D

Study	Year	Country	Tooth	Size	SD	Mean [95% CI]
Meinl	2007	Austria	UR8			
Meinl	2007	Austria	UL8			
Meinl	2007	Austria	LL8	20	1.8	15.4 [14.61,16.19]
Meinl	2007	Austria	LR8	16	2	15.5 [14.52,16.48]
Lopez	2013	Brazil	UR8	16	2.3	17.4 [16.27,18.53]
Lopez	2013	Brazil	UL8	29	2.61	18.3 [17.35,19.25]
Lopez	2013	Brazil	LL8	31	1.78	18.2 [17.57,18.83]
Lopez	2013	Brazil	LR8	31	2.14	18.4 [17.65,19.15]
Zeng	2010	China	UR8	506	1.63	13.8 [13.66,13.94]
Zeng	2010	China	UL8	504	1.65	13.82 [13.68,13.96]
Zeng	2010	China	LL8	439	1.73	13.73 [13.57,13.89]
Zeng	2010	China	LR8	443	1.72	13.86 [13.7,14.02]
Li	2012	China	UR8	198	2.3	13.8 [13.48,14.12]
Li	2012	China	UL8	196	2.2	13.8 [13.49,14.11]
Li	2012	China	LL8	149	2.2	14.4 [14.05,14.75]
Li	2012	China	LR8	149	2.2	14.6 [14.25,14.95]
Guo	2014	China	UR8	447	2.02	13.39 [13.21,13.58]
Guo	2014	China	UL8	436	2	13.43 [13.25,13.62]
Guo	2014	China	LL8	446	1.87	13.5 [13.33,13.68]
Guo	2014	China	LR8	405	1.83	13.42 [13.24,13.6]
Guo	2015	China	UR8	424	1.92	13.28 [13.1,13.46]
Guo	2015	China	UL8	416	1.95	13.26 [13.07,13.45]
Guo	2015	China	LL8	413	1.79	13.21 [13.04,13.38]
Guo	2015	China	LR8	366	1.65	13.04 [12.87,13.21]
Rouge−Maillart	2011	France	UR8	35	1.1	14.57 [14.21,14.93]
Rouge−Maillart	2011	France	UL8	34	1.11	14.55 [14.18,14.92]
Rouge−Maillart	2011	France	LL8	40	1.3	14.77 [14.37,15.17]
Rouge−Maillart	2011	France	LR8	39	1.28	14.74 [14.34,15.14]
Zandi	2015	Iran	UR8	155	2.44	13.42 [13.04,13.8]
Zandi	2015	Iran	UL8	148	2.36	13.41 [13.03,13.79]
Zandi	2015	Iran	LL8	125	2.47	14.02 [13.59,14.45]
Zandi	2015	Iran	LR8	124	2.3	13.78 [13.38,14.18]
Johan	2012	Malaysia	UR8			
Johan	2012	Malaysia	UL8			
Johan	2012	Malaysia	LL8	69	1.23	15.16 [14.87,15.45]
Johan	2012	Malaysia	LR8	57	1.3	15.19 [14.85,15.53]
Elshehawi	2016	Malta	UR8	155	1.33	13.62 [13.41,13.83]
Elshehawi	2016	Malta	UL8	83	0.85	14.57 [14.39,14.75]
Elshehawi	2016	Malta	LL8	73	0.89	14.46 [14.26,14.66]
Elshehawi	2016	Malta	LR8	115	1.5	13.62 [13.35,13.89]
Olze	2010	Native Canada	UR8	26	1.5	14.5 [13.92,15.08]
Olze	2010	Native Canada	UL8	25	1.6	14.1 [13.47,14.73]
Olze	2010	Native Canada	LL8	10	1.3	14 [13.19,14.81]
Olze	2010	Native Canada	LR8	15	2	14.4 [13.39,15.41]
Olze	2006	South Africa	UR8	11	3.1	13.9 [12.07,15.73]
Olze	2006	South Africa	UL8	12	3.4	14.1 [12.18,16.02]
Olze	2006	South Africa	LL8	12	2.5	13.6 [12.19,15.01]
Olze	2006	South Africa	LR8	10	2.6	14 [12.39,15.61]
Olze	2012	South Africa	UR8			
Olze	2012	South Africa	UL8			
Olze	2012	South Africa	LL8			
Olze	2012	South Africa	LR8			
Lee	2009	South Korea	UR8	103	1.7	14.4 [14.07,14.73]
Lee	2009	South Korea	UL8	100	1.7	14.3 [13.97,14.63]
Lee	2009	South Korea	LL8	128	1.6	15 [14.72,15.28]
Lee	2009	South Korea	LR8	125	1.5	14.9 [14.64,15.16]
Prieto	2004	Spain	UR8			
Prieto	2004	Spain	UL8			
Prieto	2004	Spain	LL8	85	1	15.11 [14.9,15.32]
Prieto	2004	Spain	LR8	87	0.97	15.12 [14.92,15.32]
Karatas	2013	Turkey	UR8	78	1.46	13.02 [12.7,13.34]
Karatas	2013	Turkey	UL8	76	1.47	13.01 [12.68,13.34]
Karatas	2013	Turkey	LL8	62	1.36	13.27 [12.93,13.61]
Karatas	2013	Turkey	LR8	59	1.45	13.17 [12.8,13.54]
Karadayi	2014	Turkey	UR8			
Karadayi	2014	Turkey	UL8			
Karadayi	2014	Turkey	LL8	59	1.83	14.01 [13.54,14.48]
Karadayi	2014	Turkey	LR8			
Boonpitaksathit	2011	UK	UR8			
Boonpitaksathit	2011	UK	UL8			
Boonpitaksathit	2011	UK	LL8			
Boonpitaksathit	2011	UK	LR8			

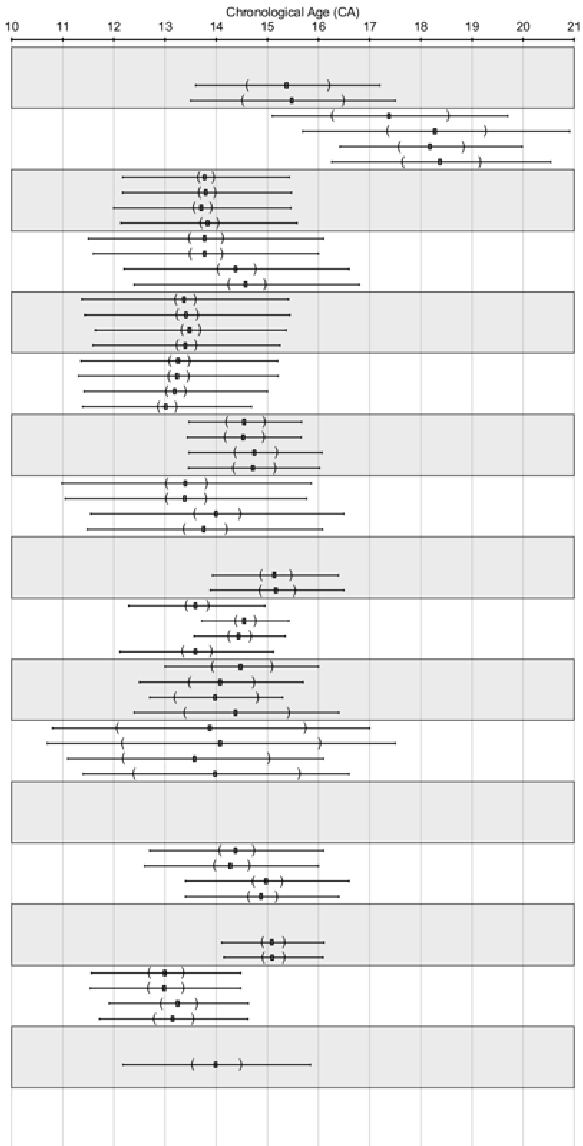


Figure A13: Mean chronological age for girls in Demirjian's development stage E for all four third molars from each of the included studies (if data available from article).

Gender=Female − Stage=E

Study	Year	Country	Tooth	Size	SD	Mean [95% CI]
Meinl	2007	Austria	UR8			
Meinl	2007	Austria	UL8			
Meinl	2007	Austria	LL8	21	2.5	17.8 [16.73,18.87]
Meinl	2007	Austria	LR8	20	2.8	17.2 [15.97,18.43]
Lopez	2013	Brazil	UR8	31	2.05	18.4 [17.68,19.12]
Lopez	2013	Brazil	UL8	22	1.88	18.2 [17.41,18.99]
Lopez	2013	Brazil	LL8	38	2.03	18.1 [17.45,18.75]
Lopez	2013	Brazil	LR8	47	2.17	18.1 [17.48,18.72]
Zeng	2010	China	UR8	181	1.84	16.05 [15.78,16.32]
Zeng	2010	China	UL8	183	1.95	16.15 [15.87,16.43]
Zeng	2010	China	LL8	197	1.95	15.87 [15.6,16.14]
Zeng	2010	China	LR8	206	1.8	15.79 [15.54,16.04]
Li	2012	China	UR8	79	2.3	16.9 [16.39,17.41]
Li	2012	China	UL8	83	2.4	17 [16.48,17.52]
Li	2012	China	LL8	82	2.1	16.5 [16.05,16.95]
Li	2012	China	LR8	100	2.3	16.5 [16.05,16.95]
Guo	2014	China	UR8	176	2.22	15.53 [15.2,15.86]
Guo	2014	China	UL8	189	2.19	15.46 [15.14,15.77]
Guo	2014	China	LL8	293	2.47	16.23 [15.95,16.51]
Guo	2014	China	LR8	298	2.52	16.1 [15.82,16.39]
Guo	2015	China	UR8	169	2.25	15.43 [15.09,15.77]
Guo	2015	China	UL8	179	2.15	15.35 [15.04,15.66]
Guo	2015	China	LL8	211	2.38	15.64 [15.32,15.96]
Guo	2015	China	LR8	220	2.26	15.5 [15.2,15.8]
Rouge−Maillart	2011	France	UR8	25	1.35	15.78 [15.25,16.31]
Rouge−Maillart	2011	France	UL8	28	1.31	15.84 [15.35,16.33]
Rouge−Maillart	2011	France	LL8	24	1.36	15.8 [15.26,16.34]
Rouge−Maillart	2011	France	LR8	24	1.36	15.8 [15.26,16.34]
Zandi	2015	Iran	UR8	74	2.19	13.68 [13.18,14.18]
Zandi	2015	Iran	UL8	72	2.18	15.56 [15.06,16.06]
Zandi	2015	Iran	LL8	89	2.35	15.92 [15.43,16.41]
Zandi	2015	Iran	LR8	92	2.35	16.09 [15.61,16.57]
Johan	2012	Malaysia	UR8			
Johan	2012	Malaysia	UL8			
Johan	2012	Malaysia	LL8	69	1.23	15.98 [15.69,16.27]
Johan	2012	Malaysia	LR8	71	1.29	15.93 [15.63,16.23]
Elshehawi	2016	Malta	UR8	42	1.41	15.2 [14.77,15.63]
Elshehawi	2016	Malta	UL8	38	1	15.32 [15,15.64]
Elshehawi	2016	Malta	LL8	68	1.38	15.36 [15.03,15.69]
Elshehawi	2016	Malta	LR8	68	1.46	15.15 [14.8,15.5]
Olze	2010	Native Canada	UR8	39	2.4	15.8 [15.05,16.55]
Olze	2010	Native Canada	UL8	46	2.2	16.1 [15.46,16.74]
Olze	2010	Native Canada	LL8	23	2.7	16 [14.9,17.1]
Olze	2010	Native Canada	LR8	19	2.9	15.7 [14.4,17]
Olze	2006	South Africa	UR8	17	1.8	15.5 [14.64,16.36]
Olze	2006	South Africa	UL8	15	1.6	15.2 [14.39,16.01]
Olze	2006	South Africa	LL8	13	1.8	15.7 [14.72,16.68]
Olze	2006	South Africa	LR8	14	2.3	15.9 [14.7,17.1]
Olze	2012	South Africa	UR8			
Olze	2012	South Africa	UL8			
Olze	2012	South Africa	LL8			
Olze	2012	South Africa	LR8			
Lee	2009	South Korea	UR8	134	1.6	15.9 [15.63,16.17]
Lee	2009	South Korea	UL8	131	1.6	15.9 [15.63,16.17]
Lee	2009	South Korea	LL8	142	1.7	16.4 [16.12,16.68]
Lee	2009	South Korea	LR8	137	1.6	16.2 [15.93,16.47]
Prieto	2004	Spain	UR8			
Prieto	2004	Spain	UL8			
Prieto	2004	Spain	LL8	137	1.43	16 [15.76,16.24]
Prieto	2004	Spain	LR8	138	1.17	15.86 [15.66,16.06]
Karatas	2013	Turkey	UR8	10	0.76	14.37 [13.9,14.84]
Karatas	2013	Turkey	UL8	9	0.69	14.49 [14.04,14.94]
Karatas	2013	Turkey	LL8	9	0.78	14.29 [13.78,14.8]
Karatas	2013	Turkey	LR8	9	0.78	14.29 [13.78,14.8]
Karadayi	2014	Turkey	UR8			
Karadayi	2014	Turkey	UL8			
Karadayi	2014	Turkey	LL8	42	2.4	16.47 [15.74,17.2]
Karadayi	2014	Turkey	LR8			
Boonpitaksathit	2011	UK	UR8	181	2.98	15.34 [14.91,15.77]
Boonpitaksathit	2011	UK	UL8	200	1.37	14.98 [14.79,15.17]
Boonpitaksathit	2011	UK	LL8	188	1.28	15.45 [15.27,15.63]
Boonpitaksathit	2011	UK	LR8	178	1.35	15.59 [15.39,15.79]

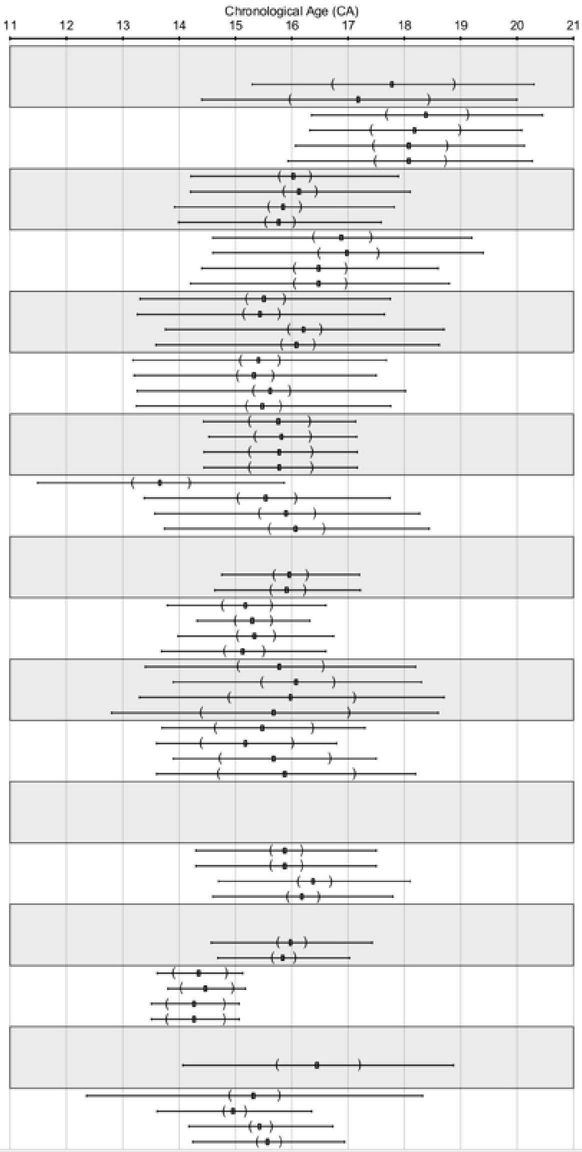


Figure A14: Mean chronological age for girls in Demirjian's development stage F for all four third molars from each of the included studies (if data available from article).

Gender=Female – Stage=F

Study	Year	Country	Tooth	Size	SD	Mean [95% CI]
Meinl	2007	Austria	UR8			
Meinl	2007	Austria	UL8			
Meinl	2007	Austria	LL8	37	2.4	18.4 [17.63,19.17]
Meinl	2007	Austria	LR8	47	2.3	18.5 [17.84,19.16]
Lopez	2013	Brazil	UR8	17	2.15	18.6 [17.58,19.62]
Lopez	2013	Brazil	UL8	75	2.09	18.6 [18.13,19.07]
Lopez	2013	Brazil	LL8	55	2.21	18.5 [17.92,19.08]
Lopez	2013	Brazil	LR8	54	2.22	18.7 [18.11,19.29]
Zeng	2010	China	UR8	99	1.98	18.21 [17.82,18.6]
Zeng	2010	China	UL8	96	1.91	18.23 [17.85,18.61]
Zeng	2010	China	LL8	124	2.1	17.97 [17.6,18.34]
Zeng	2010	China	LR8	122	2.06	17.85 [17.48,18.22]
Li	2012	China	UR8	69	2.1	18.9 [18.4,19.4]
Li	2012	China	UL8	73	2.1	18.9 [18.42,19.38]
Li	2012	China	LL8	81	2.5	17.9 [17.36,18.44]
Li	2012	China	LR8	72	2.3	18.2 [17.67,18.73]
Guo	2014	China	UR8	59	2.61	18.82 [18.15,19.48]
Guo	2014	China	UL8	63	2.8	19.05 [18.35,19.74]
Guo	2014	China	LL8	174	2.85	20.24 [19.81,20.66]
Guo	2014	China	LR8	175	2.9	19.98 [19.55,20.41]
Guo	2015	China	UR8	49	2.29	18.35 [17.71,18.99]
Guo	2015	China	UL8	57	2.4	18.6 [17.98,19.22]
Guo	2015	China	LL8	92	2.78	19.68 [19.11,20.25]
Guo	2015	China	LR8	91	2.75	19.22 [18.65,19.79]
Rouge-Maillart	2011	France	UR8	16	3.8	17.45 [15.59,19.31]
Rouge-Maillart	2011	France	UL8	17	3.69	17.39 [15.64,19.14]
Rouge-Maillart	2011	France	LL8	18	2.81	16.78 [15.48,18.08]
Rouge-Maillart	2011	France	LR8	18	2.95	16.92 [15.56,18.28]
Zandi	2015	Iran	UR8	76	2.38	17.13 [16.59,17.67]
Zandi	2015	Iran	UL8	77	2.13	16.88 [16.4,17.36]
Zandi	2015	Iran	LL8	61	2.25	17.36 [16.8,17.92]
Zandi	2015	Iran	LR8	62	2.54	17.52 [16.89,18.15]
Johan	2012	Malaysia	UR8			
Johan	2012	Malaysia	UL8			
Johan	2012	Malaysia	LL8	70	1.53	17.8 [17.44,18.16]
Johan	2012	Malaysia	LR8	66	1.46	17.92 [17.57,18.27]
Elshehawi	2016	Malta	UR8	39	1.11	17.25 [16.9,17.6]
Elshehawi	2016	Malta	UL8	30	0.79	16.06 [15.78,16.34]
Elshehawi	2016	Malta	LL8	52	1.65	17.23 [16.78,17.68]
Elshehawi	2016	Malta	LR8	28	0.97	15.78 [15.42,16.14]
Olze	2010	Native Canada	UR8	44	2	18.1 [17.51,18.69]
Olze	2010	Native Canada	UL8	39	2.1	18.1 [17.44,18.76]
Olze	2010	Native Canada	LL8	29	2.2	18 [17.2,18.8]
Olze	2010	Native Canada	LR8	30	1.8	18.4 [17.76,19.04]
Olze	2006	South Africa	UR8	5	2.7	18.6 [16.23,20.97]
Olze	2006	South Africa	UL8	3	1.4	17 [15.42,18.58]
Olze	2006	South Africa	LL8	15	2.5	17.1 [15.83,18.37]
Olze	2006	South Africa	LR8	14	2.5	17.4 [16.09,18.71]
Olze	2012	South Africa	UR8			
Olze	2012	South Africa	UL8			
Olze	2012	South Africa	LL8			
Olze	2012	South Africa	LR8			
Lee	2009	South Korea	UR8	128	1.9	17.5 [17.17,17.83]
Lee	2009	South Korea	UL8	133	1.9	17.5 [17.18,17.82]
Lee	2009	South Korea	LL8	112	1.9	17.6 [17.25,17.95]
Lee	2009	South Korea	LR8	132	1.9	17.7 [17.38,18.02]
Prieto	2004	Spain	UR8			
Prieto	2004	Spain	UL8			
Prieto	2004	Spain	LL8	238	1.56	16.83 [16.63,17.03]
Prieto	2004	Spain	LR8	225	1.53	16.82 [16.62,17.02]
Karatas	2013	Turkey	UR8	2	0	15
Karatas	2013	Turkey	UL8	2	0	15
Karatas	2013	Turkey	LL8	2	0	15
Karatas	2013	Turkey	LR8	2	0	15
Karadayi	2014	Turkey	UR8			
Karadayi	2014	Turkey	UL8			
Karadayi	2014	Turkey	LL8	65	1.95	17.75 [17.28,18.22]
Karadayi	2014	Turkey	LR8			
Boonpitaksathit	2011	UK	UR8	191	1.13	16.21 [16.05,16.37]
Boonpitaksathit	2011	UK	UL8	197	1.2	16.16 [15.99,16.33]
Boonpitaksathit	2011	UK	LL8	165	1.35	16.68 [16.47,16.89]
Boonpitaksathit	2011	UK	LR8	162	1.29	16.46 [16.26,16.66]

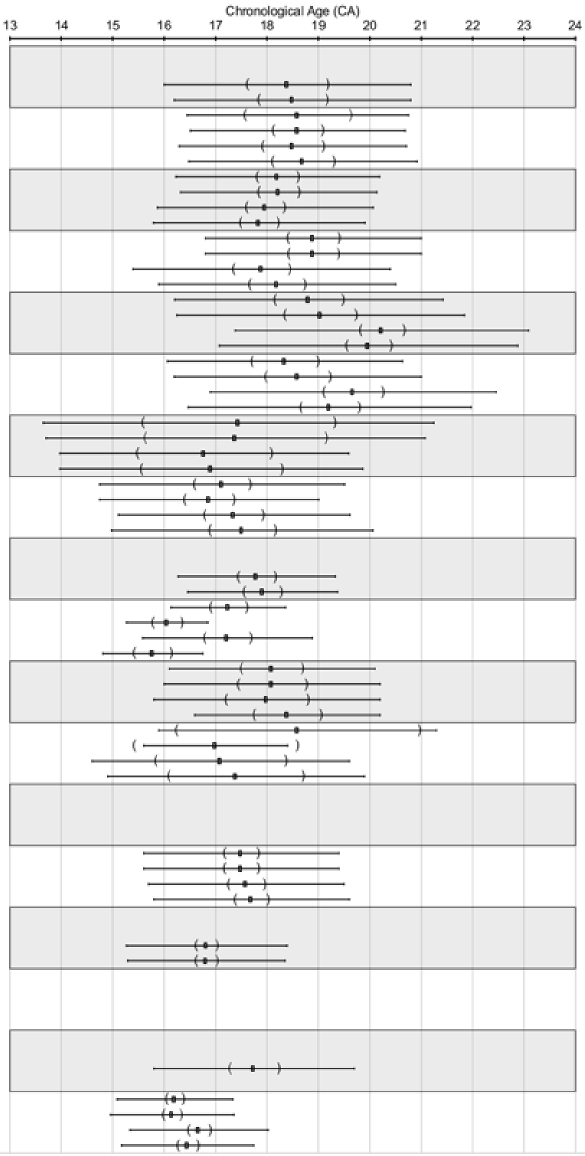


Figure A15: Mean chronological age for girls in Demirjian's development stage G for all four third molars from each of the included studies (if data available from article).

Gender=Female − Stage=G

Study	Year	Country	Tooth	Size	SD	Mean [95% CI]
Meinl	2007	Austria	UR8			
Meinl	2007	Austria	UL8			
Meinl	2007	Austria	LL8	98	2.1	20.3 [19.88,20.72]
Meinl	2007	Austria	LR8	88	2.2	20.5 [20.04,20.96]
Lopez	2013	Brazil	UR8	64	2.19	19.1 [18.56,19.64]
Lopez	2013	Brazil	UL8	84	2.18	19 [18.53,19.47]
Lopez	2013	Brazil	LL8	78	2.28	19.5 [18.99,20.01]
Lopez	2013	Brazil	LR8	78	2.19	19.4 [18.91,19.89]
Zeng	2010	China	UR8	218	2.35	20.82 [20.51,21.13]
Zeng	2010	China	UL8	224	2.37	20.85 [20.54,21.16]
Zeng	2010	China	LL8	221	2.25	20.61 [20.31,20.91]
Zeng	2010	China	LR8	232	2.21	20.62 [20.34,20.9]
Li	2012	China	UR8	92	1.8	20.2 [19.83,20.57]
Li	2012	China	UL8	74	1.9	20.3 [19.87,20.73]
Li	2012	China	LL8	122	2	19.9 [19.55,20.25]
Li	2012	China	LR8	120	1.9	19.8 [19.46,20.14]
Guo	2014	China	UR8	64	2.74	21.39 [20.72,22.06]
Guo	2014	China	UL8	48	2.58	21.23 [20.5,21.96]
Guo	2014	China	LL8	176	2.68	21.48 [21.08,21.87]
Guo	2014	China	LR8	191	2.46	21.42 [21.07,21.77]
Guo	2015	China	UR8	44	2.31	20.18 [19.5,20.86]
Guo	2015	China	UL8	36	2.13	20.61 [19.91,21.31]
Guo	2015	China	LL8	86	2.49	20.69 [20.16,21.22]
Guo	2015	China	LR8	101	2.48	21.08 [20.6,21.56]
Rouge−Maillart	2011	France	UR8	34	2.27	17.85 [17.09,18.61]
Rouge−Maillart	2011	France	UL8	34	2.27	17.85 [17.09,18.61]
Rouge−Maillart	2011	France	LL8	32	2.71	18.35 [17.41,19.29]
Rouge−Maillart	2011	France	LR8	32	2.7	18.22 [17.28,19.16]
Zandi	2015	Iran	UR8	86	2.3	18.95 [18.46,19.44]
Zandi	2015	Iran	UL8	82	2.15	19.12 [18.65,19.59]
Zandi	2015	Iran	LL8	83	2.24	19.2 [18.72,19.68]
Zandi	2015	Iran	LR8	87	2.22	19.22 [18.75,19.69]
Johan	2012	Malaysia	UR8			
Johan	2012	Malaysia	UL8			
Johan	2012	Malaysia	LL8	114	2.01	20.15 [19.78,20.52]
Johan	2012	Malaysia	LR8	121	2.03	20.09 [19.73,20.45]
Elshehawi	2016	Malta	UR8	51	1.06	19.71 [19.42,20]
Elshehawi	2016	Malta	UL8	33	1.03	19.19 [18.84,19.54]
Elshehawi	2016	Malta	LL8	49	1.09	19.51 [19.2,19.82]
Elshehawi	2016	Malta	LR8	48	1.19	19.55 [19.21,19.89]
Olze	2010	Native Canada	UR8	33	1.9	20.2 [19.55,20.85]
Olze	2010	Native Canada	UL8	40	1.8	20.2 [19.64,20.76]
Olze	2010	Native Canada	LL8	14	2.4	20.3 [19.04,21.56]
Olze	2010	Native Canada	LR8	16	2.4	20.3 [19.12,21.48]
Olze	2006	South Africa	UR8	15	2.8	20.3 [18.88,21.72]
Olze	2006	South Africa	UL8	13	2.4	19.6 [18.3,20.9]
Olze	2006	South Africa	LL8	16	2.2	19.6 [18.52,20.68]
Olze	2006	South Africa	LR8	17	2.3	19.8 [18.71,20.89]
Olze	2012	South Africa	UR8			
Olze	2012	South Africa	UL8			
Olze	2012	South Africa	LL8			
Olze	2012	South Africa	LR8			
Lee	2009	South Korea	UR8	83	2.1	19.3 [18.85,19.75]
Lee	2009	South Korea	UL8	77	1.9	19.2 [18.78,19.62]
Lee	2009	South Korea	LL8	96	1.9	19.5 [19.12,19.88]
Lee	2009	South Korea	LR8	88	1.8	19.4 [19.02,19.78]
Prieto	2004	Spain	UR8			
Prieto	2004	Spain	UL8			
Prieto	2004	Spain	LL8	86	1.44	18.41 [18.11,18.71]
Prieto	2004	Spain	LR8	84	1.37	18.48 [18.19,18.77]
Karatas	2013	Turkey	UR8			
Karatas	2013	Turkey	UL8			
Karatas	2013	Turkey	LL8			
Karatas	2013	Turkey	LR8			
Karadayi	2014	Turkey	UR8			
Karadayi	2014	Turkey	UL8			
Karadayi	2014	Turkey	LL8	58	1.76	18.92 [18.47,19.37]
Karadayi	2014	Turkey	LR8			
Boonpitaksathit	2011	UK	UR8	127	1.16	17.53 [17.33,17.73]
Boonpitaksathit	2011	UK	UL8	122	1.09	17.63 [17.44,17.82]
Boonpitaksathit	2011	UK	LL8	99	1.55	18.25 [17.95,18.55]
Boonpitaksathit	2011	UK	LR8	112	1.4	18.18 [17.92,18.44]

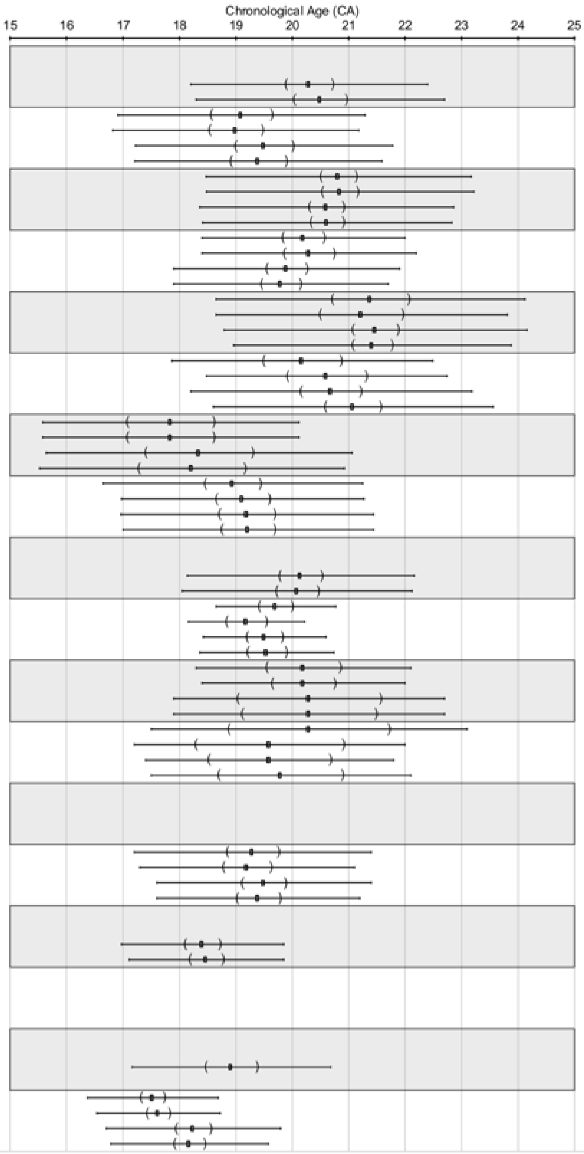
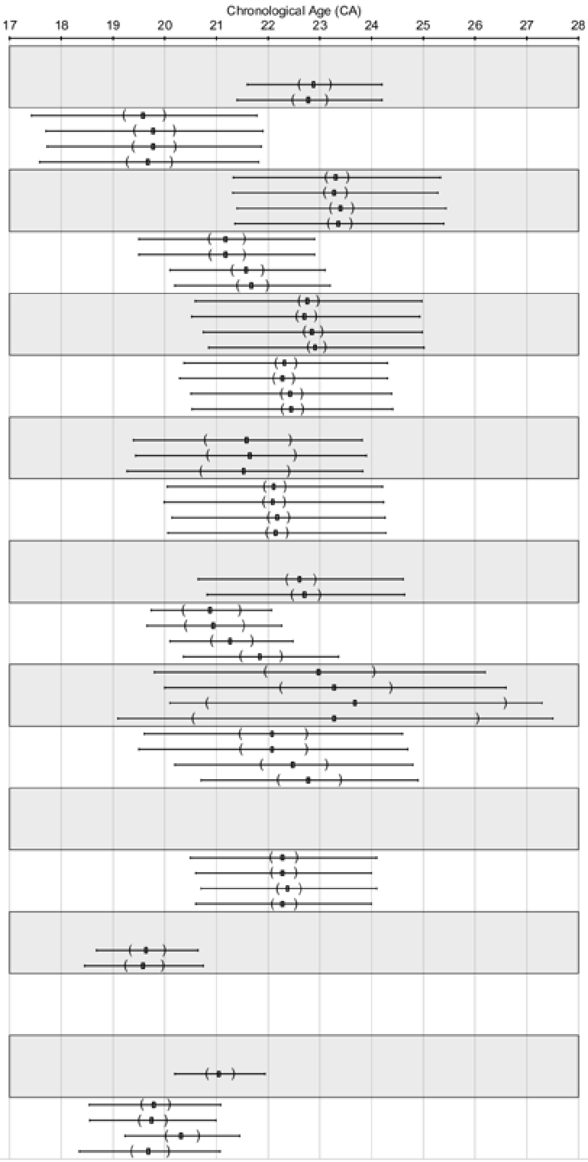


Figure A1g: Mean chronological age for girls in Demirjian's development stage H for all four third molars from each of the included studies (if data available from article).

Gender=Female − Stage=H

Study	Year	Country	Tooth	Size	SD	Mean [95% CI]
Meinl	2007	Austria	UR8			
Meinl	2007	Austria	UL8			
Meinl	2007	Austria	LL8	74	1.3	22.9 [22.6,23.2]
Meinl	2007	Austria	LR8	72	1.4	22.8 [22.48,23.12]
Lopez	2013	Brazil	UR8	126	2.18	19.6 [19.22,19.98]
Lopez	2013	Brazil	UL8	122	2.1	19.8 [19.43,20.17]
Lopez	2013	Brazil	LL8	103	2.07	19.8 [19.4,20.2]
Lopez	2013	Brazil	LR8	98	2.12	19.7 [19.28,20.12]
Zeng	2010	China	UR8	342	2	23.33 [23.12,23.54]
Zeng	2010	China	UL8	339	1.98	23.3 [23.09,23.51]
Zeng	2010	China	LL8	356	2.02	23.42 [23.21,23.63]
Zeng	2010	China	LR8	356	2.02	23.38 [23.17,23.59]
Li	2012	China	UR8	102	1.7	21.2 [20.87,21.53]
Li	2012	China	UL8	105	1.7	21.2 [20.87,21.53]
Li	2012	China	LL8	106	1.5	21.6 [21.31,21.89]
Li	2012	China	LR8	110	1.5	21.7 [21.42,21.98]
Guo	2014	China	UR8	569	2.19	22.78 [22.6,22.96]
Guo	2014	China	UL8	594	2.2	22.73 [22.55,22.91]
Guo	2014	China	LL8	642	2.11	22.87 [22.7,23.03]
Guo	2014	China	LR8	656	2.08	22.93 [22.77,23.09]
Guo	2015	China	UR8	432	1.97	22.34 [22.15,22.53]
Guo	2015	China	UL8	450	2.01	22.3 [22.11,22.49]
Guo	2015	China	LL8	379	1.94	22.45 [22.25,22.65]
Guo	2015	China	LR8	378	1.94	22.47 [22.27,22.67]
Rouge−Maillart	2011	France	UR8	1	0	20.01
Rouge−Maillart	2011	France	UL8	28	2.21	21.61 [20.79,22.43]
Rouge−Maillart	2011	France	LL8	27	2.23	21.67 [20.83,22.51]
Rouge−Maillart	2011	France	LR8	28	2.28	21.55 [20.71,22.39]
Zandi	2015	Iran	UR8	441	2.08	22.13 [21.94,22.32]
Zandi	2015	Iran	UL8	448	2.12	22.11 [21.91,22.31]
Zandi	2015	Iran	LL8	443	2.06	22.2 [22.01,22.39]
Zandi	2015	Iran	LR8	437	2.11	22.17 [21.97,22.37]
Johan	2012	Malaysia	UR8			
Johan	2012	Malaysia	UL8			
Johan	2012	Malaysia	LL8	208	1.98	22.63 [22.36,22.9]
Johan	2012	Malaysia	LR8	201	1.91	22.73 [22.47,22.99]
Elshehawi	2016	Malta	UR8	18	1.16	20.9 [20.36,21.44]
Elshehawi	2016	Malta	UL8	21	1.3	20.96 [20.4,21.52]
Elshehawi	2016	Malta	LL8	36	1.19	21.29 [20.9,21.68]
Elshehawi	2016	Malta	LR8	58	1.5	21.86 [21.47,22.25]
Olze	2010	Native Canada	UR8	36	3.2	23 [21.95,24.05]
Olze	2010	Native Canada	UL8	37	3.3	23.3 [22.24,24.36]
Olze	2010	Native Canada	LL8	6	3.6	23.7 [20.82,26.58]
Olze	2010	Native Canada	LR8	9	4.2	23.3 [20.56,26.04]
Olze	2006	South Africa	UR8	59	2.5	22.1 [21.46,22.74]
Olze	2006	South Africa	UL8	65	2.6	22.1 [21.47,22.73]
Olze	2006	South Africa	LL8	52	2.3	22.5 [21.87,23.13]
Olze	2006	South Africa	LR8	48	2.1	22.8 [22.21,23.39]
Olze	2012	South Africa	UR8			
Olze	2012	South Africa	UL8			
Olze	2012	South Africa	LL8			
Olze	2012	South Africa	LR8			
Lee	2009	South Korea	UR8	204	1.8	22.3 [22.05,22.55]
Lee	2009	South Korea	UL8	211	1.7	22.3 [22.07,22.53]
Lee	2009	South Korea	LL8	226	1.7	22.4 [22.18,22.62]
Lee	2009	South Korea	LR8	222	1.7	22.3 [22.08,22.52]
Prieto	2004	Spain	UR8			
Prieto	2004	Spain	UL8			
Prieto	2004	Spain	LL8	35	0.98	19.66 [19.34,19.98]
Prieto	2004	Spain	LR8	41	1.15	19.6 [19.25,19.95]
Karatas	2013	Turkey	UR8			
Karatas	2013	Turkey	UL8			
Karatas	2013	Turkey	LL8			
Karatas	2013	Turkey	LR8			
Karadayi	2014	Turkey	UR8			
Karadayi	2014	Turkey	UL8			
Karadayi	2014	Turkey	LL8	44	0.87	21.07 [20.81,21.33]
Karadayi	2014	Turkey	LR8			
Boonpitaksathit	2011	UK	UR8	93	1.27	19.81 [19.55,20.07]
Boonpitaksathit	2011	UK	UL8	91	1.22	19.77 [19.52,20.02]
Boonpitaksathit	2011	UK	LL8	51	1.11	20.34 [20.04,20.64]
Boonpitaksathit	2011	UK	LR8	58	1.36	19.71 [19.36,20.06]



Gender=Female − Stage=H

Study	Year	Country	Tooth	Size	SD	Mean [95% CI]
Meinl	2007	Austria	UR8			
Meinl	2007	Austria	UL8			
Meinl	2007	Austria	LL8	74	1.3	22.9 [22.6,23.2]
Meinl	2007	Austria	LR8	72	1.4	22.8 [22.48,23.12]
Lopez	2013	Brazil	UR8	126	2.18	19.6 [19.22,19.98]
Lopez	2013	Brazil	UL8	122	2.1	19.8 [19.43,20.17]
Lopez	2013	Brazil	LL8	103	2.07	19.8 [19.4,20.2]
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Rouge−Maillart	2011	France	LL8	27	2.23	21.67 [20.83,22.51]
Rouge−Maillart	2011	France	LR8	28	2.28	21.55 [20.71,22.39]
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Johan	2012	Malaysia	UL8			
Johan	2012	Malaysia	LL8	208	1.98	22.63 [22.36,22.9]
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Elshehawi	2016	Malta	LL8	36	1.19	21.29 [20.9,21.68]
Elshehawi	2016	Malta	LR8	58	1.5	21.86 [21.47,22.25]
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Olze	2010	Native Canada	LR8	9	4.2	23.3 [20.56,26.04]
Olze	2006	South Africa	UR8	59	2.5	22.1 [21.46,22.74]
Olze	2006	South Africa	UL8	65	2.6	22.1 [21.47,22.73]
Olze	2006	South Africa	LL8	52	2.3	22.5 [21.87,23.13]
Olze	2006	South Africa	LR8	48	2.1	22.8 [22.21,23.39]
Olze	2012	South Africa	UR8			
Olze	2012	South Africa	UL8			
Olze	2012	South Africa	LL8			
Olze	2012	South Africa	LR8			
Lee	2009	South Korea	UR8	204	1.8	22.3 [22.05,22.55]
Lee	2009	South Korea	UL8	211	1.7	22.3 [22.07,22.53]
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Prieto	2004	Spain	UL8			
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Prieto	2004	Spain	LR8	41	1.15	19.6 [19.25,19.95]
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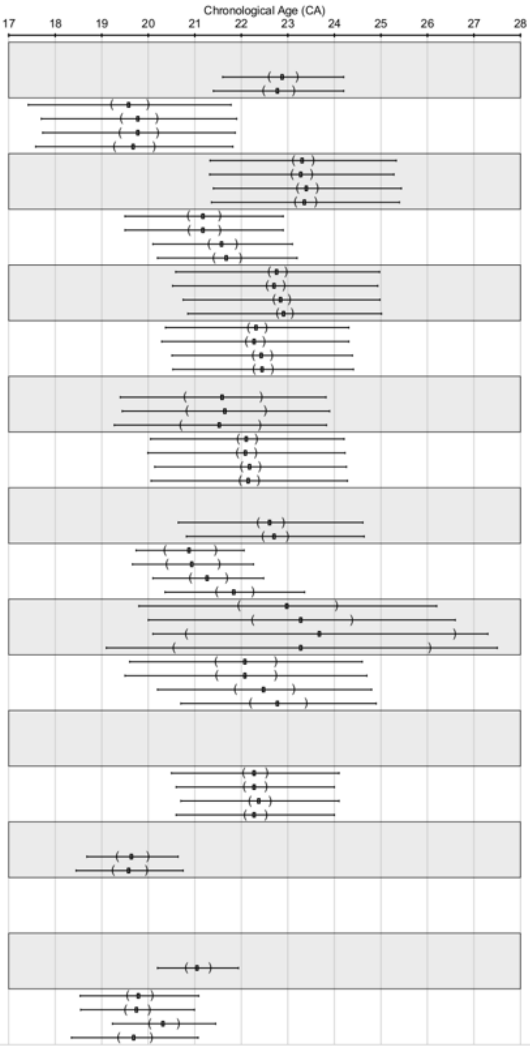
Karatas	2013	Turkey	UL8			
Karatas	2013	Turkey	LL8			
Karatas	2013	Turkey	LR8			
Karadayi	2014	Turkey	UR8			
Karadayi	2014	Turkey	UL8			
Karadayi	2014	Turkey	LL8	44	0.87	21.07 [20.81,21.33]
Karadayi	2014	Turkey	LR8			
Boonpitaksathit	2011	UK	UR8	93	1.27	19.81 [19.55,20.07]
Boonpitaksathit	2011	UK	UL8	91	1.22	19.77 [19.52,20.02]
Boonpitaksathit	2011	UK	LL8	51	1.11	20.34 [20.04,20.64]
Boonpitaksathit	2011	UK	LR8	58	1.36	19.71 [19.36,20.06]



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