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Evaluations of public health interventions produced by health technology assessment agencies: A mapping review and analysis by type and evidence content

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ABSTRACT

Objectives: Health technology assessments (HTAs) have been suggested as a strategy to bridge the evidence-to-policy gap in public health. It is unclear to what extent HTAs have been prepared to assist decisions to implement public health interventions (PHIs). We aimed to describe the experience of HTA agencies by mapping, classifying, and analyzing the evidence content of HTAs of PHIs.

Methods: We systematically searched databases of 35 HTA agencies from 18 countries for evaluations of PHIs between 2008-2018. Interventions were classified using the International Classification of Health Interventions and the evidence content analysed with the INAHTA Product-Type-mark checklist.

Results: Only 1010 (9%) of HTAs were on PHIs. 500 (50%) publications targeted *Body Systems and Functions*, 302 (30%) *Health-related Behaviours*, 137 (14%) the *Environment* and 44 (4%) *Activities and Participation Domains*. Out of 734 publications perused, few met the criteria of full-HTAs (71;10%) or mini-HTAs (110;15%). Most were rapid reviews (420;57%). 72% of all reports came from only 6 countries.

Conclusion: HTAs on PHIs were uncommon relative to clinical interventions. HTAs on population-based PHIs were less comprehensive in quality and rigor of the evidence. Countries with more resources and mature HTA-systems had done the most evaluations. Exploring the experiences of forerunners could help overcome barriers to evaluations of PHIs and exploit the full potential of HTAs to promote evidence-based public health.

1. Introduction

There have been increasing calls for more a systematic use of evidence during decision-making processes about public health interventions (PHIs) [5,6,23,26,42]. Informing public health decisions more systematically with evidence is argued to improve clarity of thought among decision-makers, strengthen public accountability and promote improved policy outcomes through a more efficient allocation of resources [1,9]. Yet, evidence-to-policy processes continue to pose a challenge to public health practitioners and policymakers [1,6,21,28,34].

To increase the use of evidence in public health decision-making, health technology assessments (HTA) have been proposed as a promising strategy [24,25]. HTAs use a multidisciplinary approach to synthesize available evidence about the consequences of an intervention to inform policy and practice [2,24]. However, HTA processes have not been widely institutionalized for public health.

In comparison, methods for appraising the evidence when evaluating clinical interventions and new drugs have refined and matured over time. These methods stem primarily from the principles of evidence-based medicine (EBM). EBM places emphasis on sys-

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tematic reviews, preferably of randomized controlled trials (RCTs), which are widely accepted as the gold standard for evaluating the safety and effectiveness clinical interventions. Public health interventions, in contrast, have features that often necessitate using evidence from other sources [13,21,22,32,34]. While there are known historical examples of trials of interventions to improve population health [30], trials can be challenging in the public health context due to practical and ethical reasons. For example, PHIs generally have outcomes that are difficult to quantify in the short-term and that spill over to sectors outside of healthcare (i.e. reducing inequalities, increasing social participation, reducing crime, and more) [22,28,34]. Research on PHIs therefore often requires a multidisciplinary approach, the involvement of several different epistemic communities [4] and quasi-experimental designs [22,39]. Methodologies for appraising and synthesizing this evidence base are also less developed [29]. A strict application of the hierarchy of evidence when appraising PHIs can lead to the impression that the evidence base is inferior both in quality and in volume [10,34,39].

National HTA agencies are increasingly venturing into the field of public health. In 2010, a study reported that PHIs represented 5% of the total share of all HTAs in Canada, UK, USA, and Denmark [25]. A survey conducted on 125 member states of the World Health Organization (WHO) in 2015 found that 40% had used HTAs to evaluate PHIs [49]. Recently, 52 HTA agencies were surveyed and 71% reported engaging in public health activities [44]. However, the same survey revealed that over 80% had evaluated less than five PHIs in the past five years. A systematic review also found that out of 45 HTA agencies, only four provided methodological guidance on how to evaluate PHIs [29]. These findings suggest that HTAs on PHIs continue to remain scarce in comparison to clinical topics and that national HTA institutions have yet formalized procedures for assessing PHIs. Surveys, however, rely on self-report and it is unclear how respondents interpreted what qualifies as a PHI. Furthermore, there has been a lack of consensus among HTA agencies on what are the necessary elements of an HTA with respect to the type of evidence included. This has motivated recent work by the International Network of Agencies for HTA (INAHTA) to develop their product-type mark (IPT-mark) that distinguishes between full-HTAs, mini-HTAs and rapid reviews [31] and a subsequent update of the definition of HTA earlier this year [33].

The share of research on PHIs prepared by HTA agencies might have increased in the last decade and can have possibly been underreported in surveys. It is unclear whether efforts are widespread or mostly concentrated in countries that have traditionally been leaders in HTAs such as the UK [43]. The primary aim of this study is to assess the experience of HTA agencies with public health by mapping published assessments of PHIs, classifying reports by types of interventions and analyzing the type of evidence they included. The reports identified could help us understand how responsive HTA work has been to major public health challenges. Furthermore, we will be able to describe the distribution of HTAs on PHIs across countries and whether increasing trends can be detected in the past decade. This knowledge can inform those who are considering implementing HTA processes for evaluating PHIs and can help identify the agencies with the most experience or agencies who are exploring this avenue.

2. Methods

2.1. Mapping review

2.1.1. Search strategy

We systematically searched the websites of HTA organizations from Europe, the United States, Canada, Australia and New Zealand that were listed as members of the International Network of Agencies for Health Technology Assessment (INAHTA) [19]. In total, the websites of 35 HTA agencies in 18 countries were scanned (see Table 2 for list of agencies). We reviewed the full list of publications because a key-word strategy for identifying assessments of PHIs was not possible to implement. A single reviewer (PRC) conducted the searches and liberally selected all potentially relevant titles evaluating public health or preventive interventions. Titles were compiled in Microsoft Excel (2016) for review by two authors (PRC, UG) using stricter inclusion criteria.

2.1.2. Inclusion and exclusion criteria

Publications that met the following inclusion criteria were retained: (1) assessment of a public health intervention (see definition below), (2) written in English, French, Spanish, Dutch, Italian, German or Nordic language and (3) published between 2008 and 2018. Publications were excluded if they were: (1) Protocols; (2) Action plans or report of activities, (3) Assessments of drugs (except for contraceptives, HIV pre-exposure prophylaxis and vaccination). Two reviewers (PRC & UG) independently assessed the titles for the inclusion criteria. When abstracts provided insufficient or unclear information, full reports were consulted to clarify the specifics of the intervention(s) being assessed. A third reviewer (TO) was consulted to resolve disagreements until consensus was reached. All the information extracted was tabulated in Microsoft Excel.

2.1.3. Scope and definition of "Public Health Intervention"

There is no consensus on a single unequivocal definition that characterizes a PHI, and a wide range of definitions have been promoted [11,14,20,35,39,40,48]. Our review aimed to identify all types of preventive interventions that have been evaluated by HTA agencies. Accordingly, we aimed to use a definition with the widest possible scope.

To define PHIs, we used the WHO's definition of public health as "the art and science of preventing disease, prolonging life and promoting health through the organized efforts of society" and of "intervention" as "an act performed for, with or on behalf of a person or population whose purpose is to assess, improve, maintain, promote or modify health, functioning or health conditions" [50]. However, due to the nature of public health challenges and how evidence is gathered to inform decisions to develop and implement PHIs, reports must sometimes study contextual parameters or mechanisms and how these form parts of a causal chain that impacts human health [14,17,40]. As explained by Cambon et al. [7] mechanisms may be the result of a combination of factors which can be human (i.e. knowledge, attitudes) or material (i.e. environmental exposures, access to care). Accordingly, our review included reports evaluating such mechanisms of action, despite not always having a clear PHI defined.

Duran and Kutzin [11] distinguishes "public health services", defined as interventions delivered to groups or the whole population, from "personal health services" delivered directly to each individual patient (i.e. counselling for smoking cessation). They consider the latter to be outside the scope of public health. However, under *our* definition of PHI, reports assessing some preventive services delivered to individuals were included on the basis that they aim to prevent illness or promote health in an otherwise healthy patient. This wider interpretation of public health aligns with how NICE has approached the appraisal of PHIs [21].

For clarity, we distinguished between individual-level and population-level interventions. Two reviewers (PRC & UG) independently classified each HTA report to one of the categories. Our definition of population-level was not restricted to interventions delivered to a group or the entire population (as proposed by [11]). Preventive interventions delivered directly to individuals were classified as population-level interventions when:

Table 1
Example of intervention classification in each of the 4 main ICHI target categories.

ICHI Target Category	Public Health Intervention	Associated ICHI 3-letter target code
Body Systems and Functions	Ex. Cervical cancer screening	NMF – Cervix uteri
Activities and Participation Domains	Ex. Back-to-work programs	SUD – Acquiring, keeping, and terminating a job
Environment	Ex. Fortification of foods	UAB – Food security and safety
Health-Related Behaviours	Ex. Counselling for tobacco use	VAB – Tobacco use behaviours

(1) they provided benefits to someone other than the person directly receiving the service (i.e. vaccination) or,
(2) the impact of the intervention was accumulated and estimated at a population-level (i.e. screening) or,
(3) the individual themselves did not seek the service but gained by being targeted (i.e. programs targeting disadvantaged groups specifically)

Disagreements were resolved by involving a third reviewer (TO) for deliberation until consensus was reached.

2.2. Data Analysis

2.2.1. Classification according to the ICHI-system

Two reviewers (PRC & VJ) independently classified all the reports retained by type of intervention using the WHO International Classification of Health Interventions (ICHI) version Beta-2 (2019) available online [52]. The ICHI classification is used to describe what health systems can provide at all levels and includes medical, surgical, primary care, community health, rehabilitation, allied health, mental health, nursing and public health interventions. The system uses three axes to describe interventions: Target, Action and Means. For this study, we only reported the first axis: "Target – the entity on which the action is carried out". ICHI separates intervention targets into 4 main categories: *Body Systems and Function, Activities and Participation Domains, Environment* and *Health-Related Behaviours*. Since public health programs can bundle interventions together and have multiple distinct targets, we created a category, *Multiple Targets,* for reports that could be classified in two or more of the categories. An example would be early childhood development programs that often include screening interventions, parental education, aid to low-income families and more. It is important to note that multiple targets are distinct from multiple interventions or complex interventions. For example, a bundle of interventions aimed at reducing smoking that includes ad campaigns, policy changes, and counselling, would still be classified under *Health-related Behaviours*.

Examples of intervention classification are provided in Table 1 below. When in disagreement, two reviewers (PRC & VJ) determined each a full 7-letter code, and a third reviewer considered both (UG). Conflicts were resolved by consensus and deliberation among the three reviewers.

2.2.2. Analysis of methodological and evidential content using the INAHTA product-type criteria

INAHTA's product type (IPT)-mark systems defines a full-HTA report as mandatorily including seven components: (1) a description of the characteristics and current use of the technology (intervention), (2) an evaluation of safety and effectiveness, (3) a determination of cost-effectiveness through modelling (when appropriate), (4) a provision of information on cost/financial impact, (5) a discussion of organizational considerations, (6) a comprehensive systematic literature review or a systematic review of high level evidence and (7) a critical appraisal of the quality of the evidence base. A report would be considered a mini-HTA if it includes all those except for a cost-effectiveness analysis and discussion of organizational considerations. Only criteria (1) and (2) are required for a report to be classified as a rapid review [31].

The evidential content of reports was analyzed by one reviewer (PRC) using the IPT-mark check list. Reports were subsequently classified according to the definition they met. Only reports from Australia, New-Zealand, Canada, France, Ireland, Norway, the United Kingdom and the United States were analyzed given the reasonable expectation that reports would be published in English, French or Norwegian, the spoken languages of the reviewer conducting the analysis (PRC).

All data from our analyses have been compiled in tables and figures presenting descriptive statistics.

3. Results

3.1. Overview

Across the 35 agency databases searched, a total of 1010 reports were identified that met our inclusion criteria (Fig. 1). All reports were included for the ICHI-classification and 734 were included for the IPT-mark analysis.

Overall, 9% of publications prepared by all HTA agencies combined were on PHIs (see Table 2). Most agencies had a proportion ranging between 3% and 20%. The four agencies with higher ratios (AVALIA-T (25%), AHRQ (25%), HIQA (34%), IACS (56%)) had most if not all publications classified under *Body Systems & Functions* (Table 2). The United Kingdom alone accounted for almost quarter of all publications included (227, 22%), and together with Canada, France, Norway, Sweden and the United States for almost three quarters (723, 72%).

To identify trends over time, we presented in the Fig. 2 below the number of publications by year for agencies who had more than 30 publications in total. An increasing trend over time could be seen in four agencies (CADTH, NIPH, SBU and NIHR), whereas no such trends were clearly visible for the others.

3.2. ICHI classification

Most reports were classified under *Body Systems and Functions* (500, 50%), followed by *Health-Related Behaviour* (302, 30%), *Environment* (137, 14%), *Activities and Participation Domains* (44, 4%) and *Multiple Targets* (27, 3%) (Table 2). Most of the evaluations on *Activities and Participation Domains* were prepared in the UK, Denmark, and Norway (33, 75%). Over half of the reports with an *Environment* target (71, 52%) were prepared by CADTH, NIPH and the NIHR. Finally, around 65% of the reports targeting *Health-Related Behaviours* (198) were prepared in Norway, the UK, and the US.

We identified whether the PHIs were population-level or individual-level interventions and classified results in descriptive sub-categories under each ICHI-target based on familiar areas of public health activities (Table 3). We identified 814 reports to be population-level interventions, of which the majority were screening interventions (408 reports, 50% of all population-based interventions). A closer examination of all the screening reports together (416) revealed that 166 (40%) were screening for cancers with the largest shares on breast (46, 28%), colorectal (46, 28%) and cervical (30, 18%) cancers (not reported in Table 3). The next largest share of screening reports (117, 28%) were prenatal, neonatal, and early childhood screening programs. Screening interven-

Table 2
Number of reports and studies produced by HTA agencies in different countries and classified by type of intervention according to the four ICHI "Target" categories. An additional column was created for complex public health programs that encompass multiple interventions belonging to two or more of the four main categories.

	HTA Agency		Body Systems and Functions	Activities and Participation Domains	Environment	Health-Related Behaviours	Multiple Targets	Total	Total no. titles screened	%HTAs on PHIs
Australia & New Zealand	Adelaide HTA	*AHTA*	18	-	1	9	-	28	214	13%
	Health Technology Reference Group	*HTRG*	12	-	-	1	-	13	167	8%
Austria	Austrian Institute for HTA	*AIHTA*	8	-	2	3	2	15	303	5%
	Gesunheit Österreich GmbH	*GoEG*	5	3	5	5	2	20	266	8%
Belgium	Belgian Health Care Knowledge Centre	*KCE*	11	-	1	-	-	12	60	20%
Canada	Canadian Agency for Drugs and Technologies in Health	*CADTH*	65	0	33	21	1	120	2207	5%
	Evidence Development and Standards Branch	*HQO*	25	1	2	1	1	30	299	10%
	Institute of Health Economics	*IHE*	11	-	4	5	-	20	153	13%
	Institut national d'excellence en santé et en services	*INESSS*	15	-	8	2	-	25	376	7%
Denmark	Social & Health Services and Labour Market	*DEFACTUM*	8	7	2	6	-	23	444	5%
Finland	Finnish Coordinating Center for HTA	*FINCCHTA*	-	-	-	-	-	0	72	0%
France	Haute Autorité de Santé	*HAS*	42	-	4	-	-	46	1410	3%
	Comité d'Évaluation et de Diffusion des Innovations Techno.	*CEDIT*	-	-	-	-	-	0	25	0%
Germany	The Federal Joint Committee (Gemeinsamer Bundesausschuss)	*G-BA*	7	-	-	1	-	8	271	3%
	Institut für Qualität und Wirtschaftlichkeit im Gesundheitswesen	*IQWiG*	17	-	-	7	-	24	151	16%
Ireland	Health Information and Quality Authority	*HIQA*	8	-	2	1	-	11	32	34%
Italy	The Agency for Regional Healthcare	*Agenas*	2	-	-	-	-	2	39	5%
	Agenzia Sanitaria e Sociale Regionale	*ASSR*	4	2	9	4	2	21	487	4%
	HTA Unit in A. Gemelli Teaching Hospital	*UVT*	-	-	-	-	-	0	0	0%
Netherlands	Zorginstituut Nederland	*ZIN*	13	-	-	6	-	19	646	3%
	The Netherlands Org. for Health Research and Develop.	*ZonMw*	9	1	3	6	-	19	300[a]	6%
Norway	Norwegian Institute of Public Health	*NIPH*	12	10	19	31	8	80	449	18%
Spain	Agencia de Evaluación de Tecnologias Sanitarias	*AETS*	3	-	-	1	-	4	35	11%
	Andalusian Agency for HTA	*AETSA*	18	-	1	-	-	19	283	7%
	Agència de Qualitat i Avaluació Sanitàries de Catalunya	*AQuAS*	3	-	1	2	-	6	54	11%
	Galician Agency for HTA	*AVALIA-T*	16	-	-	3	-	19	76	25%
	Health Sciences Institute in Aragon	*IACS*	10	-	-	-	-	10	18	56%
	Basque Office for HTA	*OSTEBA*	6	-	3	4	1	14	145	10%
Sweden	Swedish Agency for HTA and Assessment of Social Services	*SBU*	17	4	7	16	1	45	509	9%
Switzerland	Swiss Federal Office of Public Health	*SFOPH*	-	-	-	-	-	0	1	0%
United Kingdom	National Institute for Health Research	*NIHR*	32	11	19	84	1	147	860	17%
	National Institute for Health and Care Excellence	*NICE*	4	5	7	51	5	72	589	12%
	Healthcare Improvement Scotland	*HIS*	6	-	-	-	-	6	47	13%
	Health Technology Wales	*HTW*	1	-	-	1	-	2	26	8%
United States	Agency for Healthcare Research and Quality	*AHRQ*	92	-	4	31	3	130	512	25%
		TOTAL	**500**	**44**	**137**	**302**	**27**	**1010**	**11526**	**9%**

* Denominator (n=300) is only an approximation based on [45].

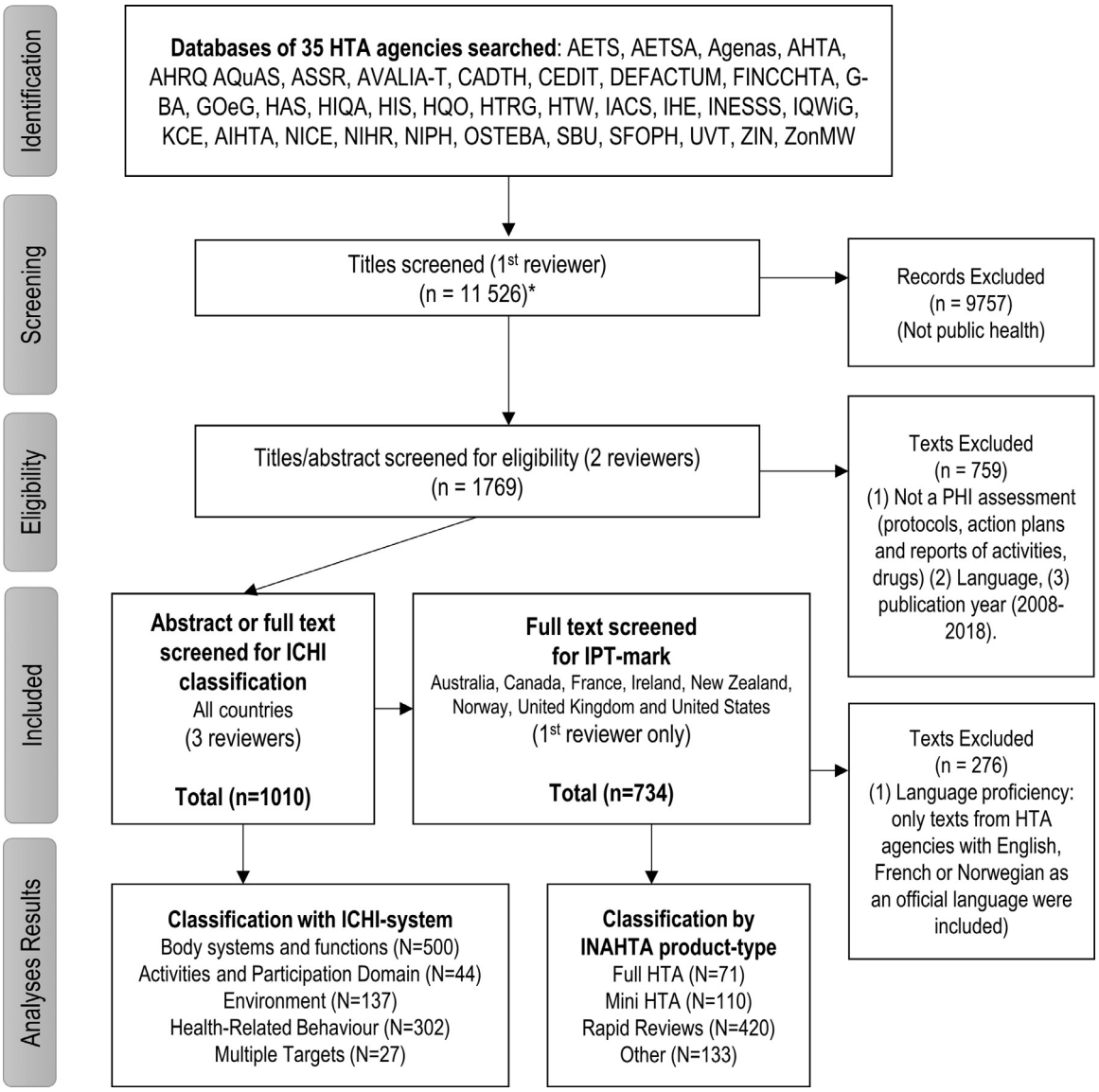

Fig. 1. Mapping review and classification of reports evaluating PHIs prepared by HTA agencies. * The format of the ZonMw website did not provide a count for the number of publications or allow possibility for a manual count. Therefore, the total number of publications included is 300 which is only an approximation based on [45].

tions classified as population-based included traditional population screening programs, but also included targeted screening in high-risk groups and some opportunistic screening when evaluated for expansion to a population (or sub-population) program. Screening interventions classified as an individual-level intervention involved prompting, usually through an immediate medical condition or through a potential genetic relation (i.e. screening patients presenting with gastro-intestinal symptoms for H. pylori or testing for genetic predispositions family members of breast cancer patients)." These screening interventions were therefore assessed only for the benefits gained by the individuals identified and were not being considered for expansion or for their impact onto population programs.

The next largest groups, together accounting for 13% of population-level PHIs, were *epidemic preparedness and healthcare infection control* (55) along with *vaccination & infectious disease prevention* (54). It is important to note that interventions targeting hygiene behaviours in the population (i.e. washing hands) and interventions targeting sexual behaviours (use of protection) are classified under "*hygiene and sexual health*" despite also having an objective to control the spread of diseases. Finally, interventions targeting *diet, physical activity, and lifestyle* (49) accounted for 6% of population-level PHIs.

Interventions delivered at the individual-level accounted for 19% (196) of all reports. The majority of these had *Health-Related Behaviour* targets (138 reports, 69% of all individual-based). These interventions were often about providing incentives or involved forms of counselling for inducing lifestyle changes. Concrete examples include online programs to help weight reduction, or text-messaging services aiding in smoking cessation. Over 30% of reports targeting *diet, physical activity and lifestyle* were specifically targeting obesity (34), of which 70% were completed in the last 5 years. Furthermore, 32 reports were smoking prevention/cessation programs representing 41% of interventions targeting *addictions*.

Finally, while not explicitly visible in the classification of this table, a total of 53 reports did not evaluate an intervention but evaluated parameters or mechanisms part of the causal chain of a PHI. Examples of such studies included the effect of wind farms on human health, determinants of attitudes and knowledge on sugar intake or whether screening causes anxiety.

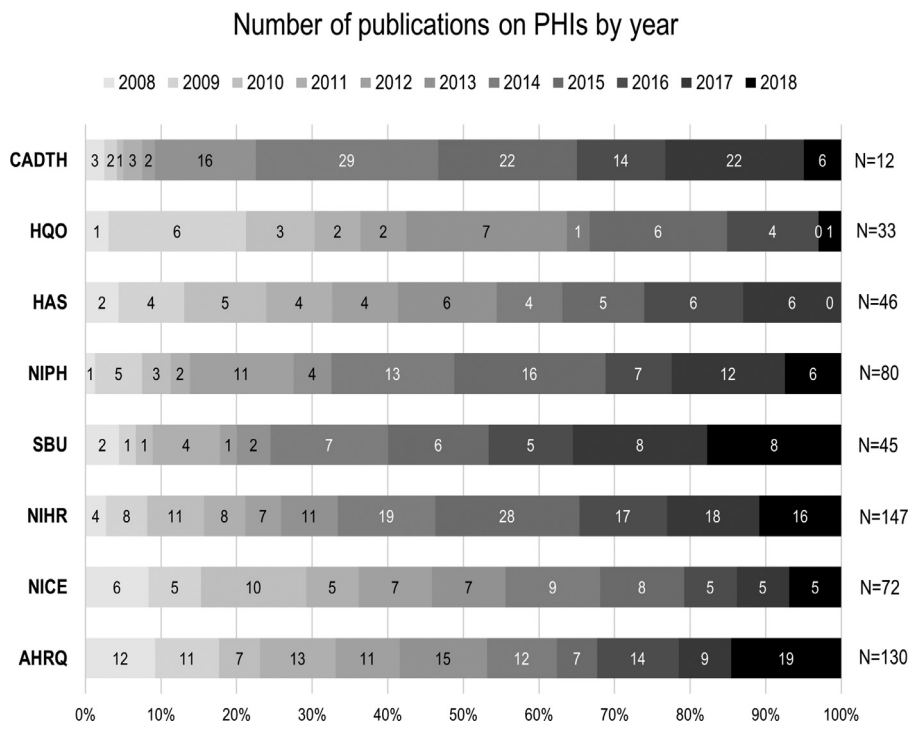

Fig. 2. Number of publications by year for agencies with a total of ≥30 publications (2008-2018). The share of publications by year is depicted by each color-graded section along the x-axis and is expressed as % of each individual agency's total. The numbers in each section represent the count of publications for that year and the total number of publications by agency is indicated at the end of each bar.

Table 3
Publications classified according to whether they are population- or individual-based and by their ICHI-target broken down into descriptive sub-categories. The full list of reports and their classification is provided in the Supplementary materials.

	Population	Individual	total	% of total (1010)
Body Systems and Functions	**482**	**18**	**500**	**50%**
Screening	408	8	416	41%
Vaccination & Infectious Disease Prevention	54	0	54	5%
Contraceptives and Nutrition	18	6	24	2%
Other	2	4	6	1%
Activities and Participation Domains	**24**	**20**	**44**	**4%**
Occupational Health & Employment	8	14	22	2%
Social Integration & Empowerment	10	3	13	1%
Educational Attainment and School Interventions	4	1	5	0%
Other	2	2	4	0%
Environment	**125**	**12**	**137**	**14%**
Expanding Health Services & Improving Access	32	8	40	4%
Housing and Social Support	12	2	14	1%
Epidemic Preparedness and Healthcare Infection Control	55	0	55	5%
Physical Environment, Exposures and Food Regulation	20	0	20	2%
Other	6	2	8	1%
Health-related Behaviours	**164**	**138**	**302**	**30%**
Addictions	39	39	78	8%
Diet, Physical Exercise and Lifestyle	49	63	112	11%
Emotional, Social Well-being and Violence Prevention	29	19	48	5%
Health Literacy and Use of Health Services	22	3	25	2%
Hygiene and Sexual Health	16	12	28	3%
Other	9	2	11	1%
Multiple Targets	**19**	**8**	**27**	**3%**
Healthy Ageing	4	4	8	1%
Mental and Social Health Programs	2	1	3	0%
Parent and Child Health Programs	5	1	6	1%
Other	8	2	10	1%
TOTAL	**814**	**196**	**1010**	

3.3. Results from the IPT-mark analysis

We used INAHTA's IPT-mark tool to evaluate how many assessments of public health interventions qualified as a full-HTA, mini-HTA, and Rapid Review. Nearly all publications analyzed provided background information on the interventions being evaluated except for some prepared by CADTH and HTW (see Table 4).

Overall, 71 (10%) reports met the criteria for full-HTA, of which the majority (35, 49%) were prepared by NICE. Only 15% of reports met the definition of mini-HTAs, while over half of the reports,

Table 4
Percentage of reports meeting individual IPT-mark criterion and percentage of reports that met all criteria to fulfill the definition for Full-HTA (all 7 criteria), Mini-HTA (all criteria except cost-effectiveness and organizational considerations) and Rapid Review (at a minimum includes current use and safety and effectiveness).

		Current Use	Safety & Effectiveness	Cost-Effectiveness	Costs/ Financial Impact	Organizational Considerations	Systematic/ Literature Review	Quality Assessment	Total	Full HTA	Mini HTA	Rapid Reviews	Other
Australia & New Zealand	*AHTA*	100%	93%	36%	46%	18%	89%	86%	28	4	1	20	3
	HTRG	100%	100%	62%	100%	38%	100%	100%	13	0	0	13	0
Canada	*CADTH*	47%	68%	23%	7%	6%	93%	39%	120	3	5	40	72
	HQO	100%	90%	27%	43%	7%	90%	63%	30	1	14	12	3
	IHE	100%	65%	55%	60%	15%	60%	40%	20	2	6	6	6
	INESSS	100%	92%	12%	4%	23%	96%	58%	26	1	2	21	2
Ireland	*HiQA*	100%	91%	91%	91%	91%	100%	64%	11	7	0	3	1
France	*HAS*	100%	93%	43%	54%	39%	85%	61%	46	12	10	21	3
Norway	*NIPH*	100%	66%	10%	4%	16%	96%	58%	80	0	4	49	27
United Kingdom	*NIHR*	100%	97%	70%	4%	35%	40%	32%	150	6	29	110	5
	NICE	100%	100%	96%	51%	100%	100%	100%	72	35	34	3	0
	HIS	100%	67%	50%	50%	17%	83%	0%	6	0	0	5	1
	HTW	0%	50%	0%	0%	0%	100%	0%	2	0	0	0	2
United States	*AHRQ*	100%	94%	5%	1%	0%	98%	92%	130	0	5	117	8
									734	**71**	**110**	**420**	**133**
									% total	**10%**	**15%**	**57%**	**18%**
Criteria:	**Full HTA**	**X**	**X**	**X**	**X**	**X**	**X**	**X**					
	Mini HTA	**X**	**X**		**X**		**X**	**X**					
	Rapid Review	**X**	**X**										

57%, met the two criteria to qualify as Rapid Review. The remaining 18% of reports that were classified as "Other" failed to meet the criteria for all 3 product-types and mostly consisted of summaries of abstracts, mapping reviews (reference lists) and qualitative studies.

Safety and effectiveness were met in over 90% or more of publications prepared by 9 out of 15 agencies. Publications prepared by CADTH and the NIPH only met the criteria 68% and 66% of the time, respectively. This relatively low number can be explained by the fact that both agencies offer "reference lists" or "mapping reviews" as a product. The IHE prepared many reports that strictly looked at costing, which explains their lower proportion (65%). For HIS and HTW, their low ratios of 67% and 50% were because no effectiveness studies were found in their systematic review' searches, not because the reviews did not attempt to evaluate safety and effectiveness.

Evidence on *cost-effectiveness* was only consistently included in reports by HiQA (91%) and NICE (96%). For half of the agencies included in this study, *cost-effectiveness* was included in less than 50% of their reports. Evidence on *costs/financial impacts* was consistently discussed in reports prepared by HTRG (100%) and HiQA (91%), whereas the rest of the agencies were split, with six that included it over 50% of the time and six that rarely did (0-7%). *Organizational considerations* were included in less than 40% of reports prepared by all agencies except those by HiQA and NICE (91% and 100% respectively).

All agencies conducted *systematic/literature reviews* in over 85% of their reports except for the NIHR (40%) and the IHE (60%). However, a *quality assessment* of the evidence was only consistently done by HTRG, NICE (100%) and AHRQ (92%). The rest of the agencies completed *quality assessments* 40-65% of the time and HIS and HTW never did (0%).

4. Discussion

In this study we aimed to gain deeper insight into the work HTA agencies have done in the field of public health in the last decade. Our review revealed, in line with what has been previously reported in the literature ([44]), that less than 10% of evaluations prepared by HTA agencies are on PHIs. Most reports were focused on interventions delivered in the clinical sector and appeared concentrated in countries with agencies recognized as leaders in the HTA world. When analyzing the rigor and comprehensiveness of the evidence included, we identified most reports to be Rapid Reviews. These findings suggest that the potential for evaluating PHIs to the full extent of the HTA methodologies available is yet to be fully exploited.

4.1. HTA activities continue to be primarily focused on interventions delivered in the clinical sector

The ICHI-classification revealed that 50% of the reports evaluating PHIs were targeting *Body systems and Functions*, which was primarily driven by a large amount of screening and vaccination interventions. Had we excluded vaccination and screening interventions from this review, the total share of reports on PHIs prepared by the HTA agencies would have been reduced from 9% to 4%. This indicates that agencies continue to primarily focus on preventive interventions delivered in the clinical sector, rather than focusing on population-based PHIs delivered in the community. By 'interventions delivered in the clinical sector' we mean personal preventive services delivered by health care workers, such as a screening test or vaccine, but also interventions such as advice about smoking cessation or advice to improve diet and physical activity to prevent non-communicable diseases. For instance, almost half of the reports in the second largest target category, *Health-related Behaviours,* were individual-level interventions and reflected how clinical activities (such as behavioural counselling) and public health goals often intersect. In general, evaluations of PHIs focusing on broad policy changes at the societal level were rare. For example, interventions such as those aiming to facilitate walking and cycling or regulating the advertising of unhealthy foods represented only 15% (20/137) of all reports classified under the target *Environment*. Adding together all population-based interventions classified under *Activities & Participation Domains, Environment* (but

excluding *Expanding Health Services & Improving Access* and *Epidemic Preparedness and Healthcare Infection Control*), *Health-related Behaviours* (but excluding *Health Literacy* and *Use of Health Services*) and *Multiple Targets*, leaves us with 223 reports. This means that PHIs delivered outside the clinical sector and into the community likely represent less than a quarter (<22%) of all titles retained in our review and <2% of all HTAs prepared." Our findings are consistent with recent survey results by [44] where HTA agencies self-reported their evaluations of PHIs and revealed that ~55% were screening interventions or infectious disease prevention and ~12% were behavioural interventions (when tobacco cessation interventions were included).

While these findings appear to suggest that efforts to evaluate PHIs are trivial, it is important to note that they align with how health care resources are allocated in those countries. According to a recent study, OECD-member countries spend only between 2% and 4% of their health budgets on preventive activities [15]. Half of those expenditures went towards funding health check-ups and dental examinations, while the second largest share (10%) went to screening and immunization programs. Interestingly, only two reports we found (rapid reviews) were on regular health checks and had doubtful conclusions on their cost-effectiveness. Given that the National Health Service Health Checks is the largest preventive initiative in England, an evaluation of the program was commissioned, and researchers reported a lack of national studies on the uptake of the service and limited evidence of effectiveness [46]. Since health checks represent a large part of spending on prevention, other countries should also consider evaluating them in the future. The study of OECD countries also reported that increased spending on prevention was largely attributed to the rolling out of population-based screening programs, and particularly those for breast and cervical cancer [15]. This is aligned with our findings that 41% of all interventions targeting *Body systems and functions* were *screening* interventions and many of which were breast, colorectal and cervical cancer screening programs. The OECD study commented on population health trends and observed that, while smoking is decreasing, obesity continues to be on the rise [15]. Our review found that interventions on smoking and tobacco represented 41% of the category on *addictions*, but reports prepared on this topic did not increase over the decade. On the other hand, reports specifically targeting obesity represented 30% of those classified under *diet, physical activity and lifestyle* and appeared to have an increasing trend over time, with 70% of the work completed in the past 5 years. This suggests that the work undertaken by HTA agencies may be somewhat responsive to important public health challenges.

The overall low number of PHIs being evaluated compared to clinical interventions may also be explained by the fact that they are challenging to evaluate [21,32] and the expertise and methodologies are still under development. Furthermore, most HTA agencies have a limited mandate, are typically funded to evaluate clinical interventions, and possibly lack the resources to diversify into public health. However, recent experience with the COVID-19 pandemic has illustrated the importance of investments in evaluations of preventive public health interventions. Given that reports on *epidemic preparedness and healthcare infection control* interventions only represented 6% of all PHIs evaluated, it is unsurprising that evidence in the form of HTA was limited to support decision-makers in the early stages of the pandemic.

4.2. Agencies that assessed most public health interventions are amongst the most mature and resourced

The largest number of reports were prepared by agencies in the UK, Canada, US, Norway, France and Sweden of which all (except France) have HTA agencies considered to be forerunners and have had time to experiment with their powers and design [27]. These countries have moved progressively to create links between their HTA agencies and the public health sector over time.

In the United Kingdom, NICE absorbed a public health responsibility under its remit in 2005. While this responsibility was dissolved in 2013, they continue to prepare public health guidelines. NICE is the most well-staffed and second most resourced of the all the agencies included in this review. The INAHTA website reports that NICE has over 680 permanent employees and average annual budgets of 90 million USD. In comparison, at least 14 out of the 35 agencies included in this review have annual budgets of less than 5 million USD, and 19 agencies have less than 50 permanent staff.

The NIHR is the only agency included that has a larger budget than NICE. However, the NIHR is a research *funder*, not an agency staffed with a permanent HTA team. It is unsurprising that the NIHR had the largest share of reports we found since they commission academics and subsequently publish the research results in their open access journals. It is important to note that NICE and the NIHR have a synergistic relationship. NICE makes research recommendations when they identify gaps in the literature. Research to fill those gaps is then subsequently commissioned and funded by the NIHR and the results of these studies ultimately returns to NICE and is used when they prepare or update guidelines. Many reports by the NIHR consists of primary research (RCTs and feasibility trials) as opposed to evidence synthesis you would typically find in full-HTAs prepared by NICE. There was no easy way to identify how many studies funded by the NIHR were used by NICE, but one should assume some overlap exists.

Both the SBU in Sweden and CADTH in Canada were founded in the 1980s making them the oldest HTA agencies included in this study. These agencies may therefore have had more time to mature and diversify their activities and expertise beyond evaluations of clinical interventions and into PHIs. Both agencies are independent national authorities tasked by the government to evaluate health interventions. While the SBU mentions working on health and social services, which can include public health, CADTH makes no explicit mention of public health, but prepares evaluations on a commission basis only.

The case of Norway is unique as the Norwegian Institute of Public Health (NIPH) earned the recognition of HTA agency when it absorbed the Norwegian Knowledge Centre for Health Services in 2016. This unit therefore culminates from well over 30 years of experience doing HTA work. The high number of publications on PHIs retained for Norway may in part be explained by the fact that many were exploration of public health topics pre-dating their HTA-agency designation. The continued interest may be explained by the fact that HTA expertise now resides under the same roof as the public health agency and collaborations between experts is facilitated.

The United States was the first country to have an HTA body [3,27] and the establishment of AHRQ likely benefited from the pre-existing expertise residing the country. The AHRQ was specifically founded to advise decisions for Medicare and Medicaid. Their high number of reports can also in part be explained by their close collaboration with the US Preventive Services Task Force. Although the AHRQ is a younger agency by comparison (2003) it was established during a wave of institutionalization of HTA and creation of new agencies during the 2000s [27]. These agencies have been coined the name of "mainstreamers" as their design was greatly inspired by that of forerunner agencies. France's HAS was also created in that same period (2004) and they formed a commission for the evaluation of PHIs in 2008 [16]. This can in part explain why we found a large number of reports on PHIs. The role HAS played in helping other European countries establish HTA units suggest they are well-resourced with expertise [27]. However, most reports by the AHRQ and HAS remained focused on screening and vaccination interventions.

4.3. Intuitive classification of public health interventions is challenging with the ICHI-system

While the ICHI-classification system is still in development, we chose to use it on the grounds that it offered a level of precision that other classifications found in the literature did not. The ICHI-system aims to improve decision-making by providing its users with a "common tool for reporting and analyzing health interventions for statistical, quality and reimbursement purposes" [51]. Accordingly, the codes under *Body Systems and Functions* are analogous to those in classification systems such as the ICD-10 often used by hospitals and clinics for reimbursement purposes. The coding system appears focused on the "unit costs" of the service for reimbursement, not budget costs for program implementation. The ICHI-system also presented with a lot of redundancies between target categories. For example, acquisition of sports equipment to encourage physical activity could be classified under *Environment* (UAI.RD.ZZ - *Provision of products and technology for culture, recreation and sport*), or under Health-related Behaviours (VEB.TM.ZZ - *Environment modification to influence physical activity behaviors*). Individual reviewers had to approximate codes as best as possible, and disagreements were resolved through discussion. Overall, in its current state, the ICHI-system proved challenging for presenting an intuitive categorization of PHIs, especially with respect to making visible population-based interventions. While this research did not aim to evaluate the utility of the ICHI-classification system, these challenges are important to consider when interpreting the results of our review. Similar challenges using the system were reported by [44]) and should be a topic to explore in future research.

4.4. HTA products on PHIs are limited in scope

Looking at our results from the IPT-mark, we found 71 reports met the definition of full-HTA. A recent review of HTAs on PHIs only found 10 full-HTAs [37]. However, they only included reports published between 2012 and 2016 and used more restrictive inclusion criteria than ours. When limiting our result for the same year span and inclusion criteria (excluding screening and vaccination, individual-level interventions targeting health-related behaviours, interventions expanding services in the clinical sector, and infectious disease control interventions), we were left with only 9 reports of which 5 overlapped with theirs. Those that did not overlap came from agencies either we or they had not included in the review. These findings demonstrate the reproducibility of both our studies and underscores that full-HTAs on population-based PHIs outside the clinical sector are rarely conducted.

The IPT-mark analysis further revealed that outside the few full-HTAs identified, most of the reports were built in the form of "Rapid Reviews". It is possible that agencies were specifically commissioned by decision-makers to use a rapid response methodology to answer questions. However, it is also possible that the agencies resorted to it due to other factors, such as a lack of time and capacity or due to methodological challenges when trying to do economic evaluations and modelling of PHIs (methodological shortcomings are well-documented in the literature 12,41,43,47,48]).

4.5. Strict application of the IPT-mark system can give a misleading impression of the rigor and quality of methods used in assessments of PHIs

Countries often use the same terminology to label HTA-products, but the content of these products vary widely [31]. The goal of establishing the IPT-mark system is to harmonize definitions of HTA products internationally, and label reports with a designation that reflects the evidence included. Using the IPT-mark, we found that many reports that otherwise were comprehensive on all criteria, failed to meet a product definition when missing only one criterion and ended up being classified together with less thorough assessments. For example, under the mini-HTAs, NICE had 35 reports, all of which could be argued to represent full-HTAs but lacked a separate discussion for *costs/financial impacts*. However, NICE always conducted modelling exercises for *cost-effectiveness* which require a thorough compilation of costs despite not being discussed through the lens of budgeting (cost-effective and cost-saving are not the same thing). There are occasions where *financial impacts* or *organizational considerations* may not need to be evaluated because the challenges or impacts foreseen are minor. There may also be times where for ethical reasons, evaluations of *cost-effectiveness* will not be conducted.

Many reports likely did not meet the definition of full- or mini-HTA because no *systematic*/literature *reviews* were included. Countries often evaluate the same interventions, which might be needed for contextualizing the evidence to their respective health systems. However, the necessity to duplicate systematic reviews recently conducted by another INAHTA-member is questionable [38], especially considering agencies use similar methods to appraise the quality of the evidence (i.e. GRADE). Lack of resources, time and expertise is often cited as a reason for PHIs not being evaluated [26,34,36], and collaborations between countries to prevent waste of resources could relieve some of these pressures. Therefore, the HTA-product designation "mandatorily" requiring systematic reviews should not provide incentives against this.

The Rapid Reviews in our study varied widely in their content and methodological quality. Some reports used limited literature searches and swiftly discussed effectiveness, while other reports were more comprehensive and included a full critical appraisal of the quality of the evidence and sometimes even included discussions of *cost-effectiveness*. Out of the 101 reports prepared by CADTH they call "rapid response", 37 had conducted a full *quality assessment* while the rest of reports did not even discuss effectiveness. These were commissioned reference lists or summaries of abstracts. While mapping reviews are not evaluations per say, they are still products offered by HTA agencies that are widely used by decision-makers.

Finally, we did not assess whether ethical, social or legal considerations were included, but they are increasingly incorporated in HTA reports. According to the IPT-mark, this component is only optional. This may incentivize agencies to neglect dedicating time and resources towards conducting these assessments as their optional nature can make them appear less important. However, in the context of public health, such evaluations can be of great importance. Many PHIs must balance the benefits for the population against an impediment to, or a loss of, individual rights and freedoms. These challenges were highlighted during the recent COVID-19 epidemic. Since public health decisions are often influenced by different political considerations [18,26,42], a greater emphasis on these aspects of decision-making could be valuable for supporting the implementation of PHIs [8].

4.6. Limitations

Our main objective was to characterize the experience of HTA agencies on evaluations of PHIs, and the scope limited our search to recognized HTA agencies through INAHTA membership. However, we understand that countries have other agencies, for example public health agencies or academic departments that also prepare HTA-like products but are not INAHTA members and were not captured in our study. Therefore, our results should not be interpreted as an accurate picture of all the evidence on PHIs prepared

in those countries and is an important limitation of our research design.

5. Conclusion

HTA agencies did not frequently evaluate PHIs, with their focus remaining on interventions delivered in the clinical sector. However, HTAs seem to evaluate interventions that are currently implemented and already receive funding (such as screening and vaccination) and reflect how healthcare spending is distributed in these countries. If HTAs are to be used to influence the policy agenda and encourage more investments in public health and prevention, agencies might need to be more proactive in undertaking evaluations of interventions that currently receive less funding. More HTAs are needed to evaluate population-level interventions delivered in the community and that promote health, well-being, and social participation.

Countries that have been leaders in the HTA-world and that have mature systems with formalized links to the public health system most frequently evaluated PHIs. These agencies were also amongst the most well-staffed and resourced suggesting that larger investments in the HTA systems promotes expertise diversification and evaluations of PHIs. The most resourced agencies were also the ones frequently using the rigorous methodologies expected in full-HTAs, suggesting that investments would not only boost the volume of PHIs being evaluated but also the quality and rigor of the evidence prepared. Future studies should explore the challenges and limitations associated with using HTA for PHIs, and how best to facilitate the institutionalisation of public health in HTA agencies.

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Declaration of Competing Interest

The first author is currently a doctoral fellow being supervised by the fourth and senior authors, who are currently employed at the National Institute of Public Health.

The second and third authors have no conflicts of interest to declare.

The fourth and senior authors are currently employed at the Norwegian Institute of Public Health, one of the agencies included in this review.

Supplementary materials

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