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PSYCHOSOCIAL ASPECTS OF DIABETES

DiaSHoT18: A cross-sectional national health and well-being survey of university students with type 1 diabetes

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Abstract

Objective: To achieve a better understanding in how university students live with and are able to manage their type 1 diabetes (T1D).

Methods: In 2018, all fulltime Norwegian students aged 18 to 35 years pursuing higher education were invited into a national survey, which included data on demographics and health. In all, 162 512 students fulfilled these inclusion criteria. Students that stated having diabetes were asked to answer further questions about their diabetes care.

Results: We included data from 50 054 students responding to the survey, and identified 324 students with T1D (64% females, mean age 23 years, mean HbA1c 7.65% [60 mmol/mol]). Male students had a lower HbA1c (7.28% vs 7.86%, 56 vs 62 mmol/mol), reached an HbA1c of <7.5% (58 mol/mol) more often (62.2% vs 44.2%) and were using continuous glucose measurement (CGM) less often (19.5% vs 36.7%). Exercise and smoking habits in students with T1D were equal to the non-diabetic group. More students with T1D were overweight or obese (44.1% vs 32.2%). Students who achieved an HbA1c <7.5% (58 mmol/mol) measured their blood sugar more often, had a lower body-mass index, exercised more and were smoking less. An HbA1c >7.5% (58 mmol/mol) was associated with less activity, more overweight or obesity, and smoking. The use of continuous subcutaneous insulin infusion and CGM was not associated with a better metabolic control.

Conclusions: These data have implications for the follow-up of adolescents and young adults, showing the need to focus on general lifestyle habits, especially in female subjects, whereas the use of technical devices might be of secondary importance.

KEYWORDS
diabetes mellitus, drug therapy, epidemiology, prevention and control, therapy, type 1 diabetes

1 | INTRODUCTION

Type 1 diabetes is a chronic disease that is demanding, like no other disease, a lifelong, continuous and high effort by the person with diabetes, eventual caregivers and support network. In order to keep blood glucose stable, students with type 1 diabetes have to assess a complex variety of many factors for example, carbohydrate intake and physical activity. Lack of metabolic control, resulting in too low or too high blood glucose, may cause both serious acute incidents and long-term complications. A major goal in the treatment of type 1 diabetes is the avoidance of these acute incidents and long-term complications. Glycosylated hemoglobin A1c (HbA1c) is a marker reflecting the glucose control over a longer period, and therefore routinely used during the follow-up of persons with diabetes. The International Society of Pediatric and Adolescent Diabetes (ISPAD) has defined the new treatment target for HbA1c as <53 mmol/mol (7.0%) in 2018.[1] However, most children and adolescents with type 1 diabetes do not meet this HbA1c target, according to data from national and international diabetes registries.[1-5]

The incidence of type 1 diabetes has been increasing worldwide by 2.8% to 3.4% over the last decades.[6-9] This trend is also expected to continue in the future. Norway has one of the highest incidences of type 1 diabetes in the world, with an incidence rate of 37.9 per 100.000 person years in children and adolescents under 15 years.[10] Pediatric diabetes care in Norway is solely given at hospitals with pediatric departments, and documented in detail in the Norwegian Childhood Diabetes Registry (NCDR).[10] Aside from metabolic control, the importance of healthy life style habits, such as non-smoking and physical activity, are an inherent part of the follow-up appointments in pediatric and adolescent care. There is more variation in the structure of adult diabetes care. It can be given both in primary and secondary health care, and has a lower proportion of reporting to the Norwegian Diabetes Register for Adults (NDV). Glycemic control often deteriorates during adolescence and emerging adulthood.[11,12] Therefore, the transition from pediatric to adult care is of major importance.[13] Most Norwegian pediatric departments follow up their patients until the age of 18, and have a structured transition from pediatric to adult care when the patient is turning 18.

Norway is a highly developed welfare state, both in terms of access to education and health care. Public universities provide education free of tuition fees, and the Norwegian State Educational Loan Fund provides loans and grants to all students in order to give the same possibilities for education, regardless of economic and social background, age, gender, and physical disabilities. Patients in Norway pay only a limited contribution of approximately $200 per year for the sum of all required medical expenses. The Norwegian health care system covers eventual costs for medical consultations and treatment exceeding this amount.

In 2018, the SHoT2018 study (Students' Health and Wellbeing Study) was conducted as a cross-sectional national survey of all students pursuing higher education in Norway.[14] The overall aim of the SHoT study was to examine the prevalence and trends across a range of health problems and life challenges among college and university students. Since diabetes has a high prevalence in Norway, it was also part of the survey to illuminate the specific challenges and concerns of students with diabetes.

To our knowledge, there are no specific studies published about the life of university students with type 1 diabetes. The aim of our study was to investigate how university students, who have qualified for a higher education and in a system with liberal access to both education, study loans and public health care, live with and are able to manage their type 1 diabetes.

We hypothesized that there would be positive outcomes regarding metabolic control as reflected by HbA1c, frequency of blood glucose measurements and meaningful use of insulin pumps and continuous glucose measurement (CGM), independent of the students' gender. As the importance of a healthy life style is emphasized during the continuous follow-up in pediatric diabetes care, we further hypothesized that students with type 1 diabetes would have a healthier lifestyle, including frequent physical activity, normal body-mass index (BMI), and non-smoking than their peers without diabetes.

2 | METHODS

2.1 | Procedure

The SHoT2018 study is a national student survey for higher education in Norway, initiated by the three largest student welfare organizations (Sammen [Bergen and surrounding area], Sit [Trondheim and surrounding area], and SiO [Oslo and Akershus]). In the SHoT2018 study, data were collected electronically through a web-based platform. Details of the study have been published elsewhere.[14] Briefly, the SHoT2018 was conducted between 6 February 2018 and 5 April 2018, and invited all fulltime Norwegian students aged 18 to 35 years pursuing higher education (both in Norway and abroad) to participate. In all, 162 512 students fulfilled these inclusion criteria, of whom 50 054 students completed the online questionnaires, yielding a response rate of 30.8%. The average time spent answering the questionnaire was 21 minutes. Although some universities and colleges allocated time in school classes allowing the student to complete the survey during a lecture, no teachers were instructed to provide support or assistance.

2.2 | Instruments

Students participating in the survey were asked to answer several questionnaires, which included detailed information on for example, demographics, health and health behavior and, if relevant, diabetes care.

2.3 | Demographic information

All participants indicated their gender and age, and participants were also asked about their relationship status (response options: “single”, “girl-/boyfriend”, “cohabitant”, and “married/registered partner”), as well as their accommodation status (response options: “living alone”, "living with partner", "living with friends/others in a collective", and "living with parents"). Financial difficulties were addressed with the following question: "Has it happened during the past 12 months that you/your household has had difficulty coping with the running costs, for example for food, transport, and housing?" (Response options: "never", "rarely", "sometimes", and "often"). Finally, participants were categorized as an immigrant if either the student or his/her parents were born outside of Norway.

2.4 | Health behaviors

The students were first presented the following brief definition of physical exercise: "With exercise we mean that you, for example, go for a walk, go skiing, swim, or take part in a sport". Physical activity was then assessed using three sets of questions, assessing the average number of times exercising each week, and the average intensity and average hours each time[15]: (a) "*How frequently do you exercise?*" (Never, less than once a week, once a week, 2-3 times per week, Almost every day); (b) "*If you do such exercise as frequently as once or more times a week: How hard do you push yourself?* (I take it easy without breaking into a sweat or losing my breath, I push myself so hard that I lose my breath and break into a sweat, I push myself to near-exhaustion); and (c) "*How long does each session last?*" (Less than 15 minutes, 15-29 minutes, 30 minutes to 1 hour, More than 1 hour". This 3-item questionnaire has previously been used in the large population-based Nord-Trøndelag Health Study (the HUNT studies). Previous validation studies[15,16] have demonstrated moderate correlations between the questionnaire responses and direct measurement of VO_2max during maximal work on a treadmill (r = 0.43[frequency], r = 0.40 [intensity], and r = 0.31 [duration]), with ActiReg,[17,18] an instrument that measures PA and energy expenditure (EE), in addition to the International Physical Activity Questionnaire.[19] Based on WHO's recommendation[20] that adults (≥18 years) should get at least 30 minutes of moderate-intensity and vigorous-intensity physical activity (MVPA) 5 days or more per week (=150 min/wk),[20] a dichotomous recommendation variable was created based on the students' responses on all three exercise items: (a) MVPA: 150 min/wk: students answering both "Almost every day" on the frequency item, "I push myself so hard that I lose my breath and break into a sweat" on the intensity item, and "30 minutes or more" or "More than 1 hour" on the duration item.

BMI was calculated based on self-reported body weight (kg) divided by squared height (m^2).[21,22] The BMI was then split into three categories: normal/underweight (BMI <24.9), overweight (BMI 25.0-29.9), and obesity (BMI ≥30).[23] Smoking was assessed with the following question "Do you smoke?" (Response options: "yes, daily", "yes, sometimes", and "no".

2.5 | Diabetes-related characteristics

Physical conditions were assessed by a predefined list adapted to fit this age cohort, which also included "diabetes". The list was based on a similar operationalization used in previous large population-based studies (the HUNT study[24]) and included several subcategories for most conditions/disorders (not listed here). If the student indicated "yes" for diabetes, several additional questions were asked:

1. State the type of diabetes you have (response options: "Type 1 diabetes", "Type 2 diabetes", "Gestational Diabetes", "LADA", "MODY", and "Do not know/unsure"). Only students indicating "Type 1 diabetes" were included in the current study, due to small numbers in the remaining categories.
2. What was your last HbA1c value (long-term blood sugar)? (Response options were provided in a drop-down list ranging from 4.0% to 14.9% in 0.1-intervals).
3. Which of the following aids/medications do you use? (Response options [several responses possible]: "Insulin pen", "Insulin pump", "Continuous Glucose Monitor (CGM)", and "Flash devices (eg, FreeStyle Libre)".
4. "How often do you measure your blood sugar?" (Response options: "never/a few times a month", "several times a week, but not daily", and "daily". If the response was "daily", the following question was asked: "Indicate how many times per day you measure your blood sugar:" (response options were provided in a drop-down list ranging from "1" to "10 or more").

2.6 | Statistics

IBM SPSS version 26 (SPSS Inc., Chicago, Illinois) for Mac was used for all analyses. Pearson chi-square tests were used to examine possible demographical (sex, age, marital status, accommodation status, financial difficulties, and immigrant status) and health behavior (BMI, exercise frequency, and smoking) differences between students with and without type 1 diabetes. Independent samples t tests and Pearson chi-squared tests were used to investigate gender differences in diabetes-related characteristics, as well as differences in demographic, health behaviors, and diabetes-related characteristics in students with type 1 diabetes at or above target level (HbA1C ≥53 mmol/mol, 7.5%) compared to those below. Estimated marginal means (EMM) for HbA1c was calculated controlling for diabetes age of onset and sex. There was generally little missing data, and hence missing values were handled using a list wise deletion. As the SHoT2018 study had several objectives and was not designed to be a study of students with T1D specifically, no *a priori* power calculations were conducted to ensure that the sample size had sufficient statistical power to detect differences in outcomes.

2.7 | Ethics

The SHoT2018 study was approved by the Regional Committee for Medical and Health Research Ethics in Norway (no. 2017/1176). An electronic informed consent was obtained after the participants had received a detailed introduction to the study.

3 | RESULTS

3.1 | Sample characteristics

The sample comprised 50 054 young adults (69.1% women), with a mean age of 23.2 years (SD = 3.3). In all, 373 students (0.7%) reported having diabetes, of which the large majority (87.6%; n = 324) had type 1 diabetes. The other types of diabetes were excluded from the current study (type 2 diabetes [n = 33], gestational diabetes [n = 1], LADA [n = 4], MODY [n = 5], and "do not know"/missing [n = 7]). The prevalence of type 1 diabetes was significantly higher among male students (0.8%, n = 116) compared to female students (0.6%, n = 206; *P* = .046; see Table 1). As detailed in Table 1, there were no significant differences between students with type 1 diabetes and the control group with regard to age, marital status, accommodation status, and financial difficulties. However, the proportion of immigrants was significantly lower in the type 1 diabetes group compared to the control group. In terms of health behaviors, the type 1 diabetes group did not significantly differ from the control group for exercise frequency, meeting the minimum recommended criteria for MVPA, or smoking habits, whereas the proportion of overweight/obesity was significantly higher among students with type 1 diabetes (see Table 1 for details).

3.2 | Diabetes-related characteristics

The average HbA1c in the type 1 diabetes group was 60 mmol/mol (7.65%), and significantly higher among females (62 mmol/mol, 7.86%) compared to males (56 mmol/mol, 7.28%) (see Table 2 for details). The mean age at diabetes onset was 12 years (SD = 5.60; no gender differences). In terms of insulin delivery, 57.2% reported using an insulin pen (multiple daily injections [MDI]) and 46.5% an insulin pump (continuous subcutaneous insulin infusion [CSII]) (no gender differences). In terms of glucose control, 30.5% reported using CGM (men: 36.7%, women: 19.5%, *P* = .001), and 10.8% reported using a flash glucose monitor (FGM, Freestyle Libre).

The large majority of the type 1 diabetes group (86.4%) reported measuring their blood glucose level on a daily basis, while 8.7% and 5.0% reported measuring their blood glucose only "several times a week" and "a few times a month/never", respectively. Among those measuring their blood glucose level on a daily basis, the average number of measurements was 5.21 (SD = 2.55), with no differences between male and female students.

3.3 | Characteristics of students achieving the HbA1c target

At the time of data collection, an HbA1c under 58 mmol/mol (7.5%) was the recommended treatment goal from ISPAD. We therefore categorized our study sample into students reporting an HbA1c value under 58 mmol/mol (7.5%) and students with an HbA1c of 58 mmol/mol (7.5%) or higher. A significantly larger proportion of male students (62.2%) reported an HbA1c below 58 mmol/mol (7.5%) compared to female students (44.2%; *P* = .002), while there were no differences in terms of age, marital status or accommodation status. Students achieving the HbA1c target were also characterized by less financial difficulties (*P* = .030), and being of Norwegian ethnicity (*P* = .057). Regarding health behaviors, achieving the HbA1c target was associated with lower BMI, more frequent physical exercise, meeting WHO's minimum criteria for MPVA, and not smoking cigarettes (see Table 3 for details). In terms of diabetes-related characteristics, achieving the HbA1c target was associated with older age at diabetes onset (*P* = .006), and more frequent measurements of their blood glucose level. There were no significant differences between students achieving vs not achieving the HbA1c target with regard to the usage of CGM. The students achieving an HbA1c of <58 mmol/mol (7.5%) used an insulin pump in 39.5%, while those not achieving the target were using an insulin pump in 54.9%.

The average HbA1c adjusted for age at diabetes onset and gender are displayed in Figure 1. The adjusted HbA1c was significantly lower among men (56 mmol/mol, 7.30%) than among women (62 mmol/mol, 7.86%), while no significant differences were observed for age, or marital, accommodation or immigrant status. Financial difficulties were associated with HbA1c in a dose-response manner: the more difficulties, the higher the HbA1c. A similar graded association was also observed for exercise frequency: the more exercise, the lower the HbA1c. Usage of different devices such as CSII, CGM, or FGM was not significantly associated with HbA1c, whereas frequency of testing was (see Figure 1 for details).

4 | DISCUSSION

In this national student survey for higher education in Norway, we examined how students with type 1 diabetes lived with and managed their diabetes. We found noteworthy gender aspects, such as better HbA1c control and lower usage of CGM in male students. Students with type 1 diabetes did not report higher levels of physical activity, or smoking less, as one would wish, compared with the healthy control group. Students with type 1 diabetes were more likely to be overweight or obese than their healthy peers.

Among the strengths of the current study is the relatively large group of students with type 1 diabetes, and in addition a large group of healthy controls. In addition, students can study in Norway without major economic barriers, and have broad access to excellent health care. This gives us insights into a how young adults with diabetes cope under quite optimal circumstances. Some study limitations should be noted. First, the response rate was relatively modest (31%), and we had little information about the characteristics of non-participants beyond age and gender distribution. It has been shown that non-participants of health surveys, in general have worse health than participants,[25] and as such, the current results may represent an underestimation of the true prevalence of diabetes in the target population. However, the prevalence of students with type 1 diabetes in

TABLE 1 Demographical characteristics in student with and without type 1 diabetes

	No diabetes (n = 49 981, 99.4%)		Type 1 diabetes (n = 324, 0.6%)		Pearson chi-square (df)	*P*-values
Sex	**%**	**(n)**	**%**	**(n)**	**χ^2 = 3.987 (1)**	**.046**
Women	69.1%	(34201)	64.0%	(206)		
Men	30.9%	(15270)	36.0%	(116)		
Age group					χ^2 = 6.229 (4)	.183
18-20 y	17.9%	(8758)	20.8%	(67)		
21-22 y	31.4%	(15356)	33.5%	(108)		
23-25 y	32.2%	(15793)	31.1%	(100)		
26-28 y	11.6%	(5682)	7.8%	(25)		
29-35 y	6.9%	(3385)	6.8%	(22)		
Marital status					χ^2 = .047 (1)	.829
Single	50.0%	(24800)	50.6%	(164)		
Married/partner/girl- or boyfriend	50.0%	(24786)	49.4%	(160)		
Accommodation status					χ^2 = 4.076 (3)	.253
Alone	18.3%	(9074)	22.2%	(72)		
With partner	27.4%	(13559)	24.1%	(78)		
With friends/others in a collective	46.0%	(22825)	45.1%	(146)		
With parents	8.3%	(4109)	8.6%	(28)		
Financial difficulties					χ^2 = 3.197 (2)	.202
Never	47.6%	(23566)	50.2%	(162)		
Seldom	22.8%	(11278)	18.6%	(60)		
Sometimes/often	29.7%	(14710)	31.3%	(101)		
Immigrant status					χ^2 = 5.045 (1)	.025
Ethnic Norwegian	92.0%	(45696)	95.4%	(309)		
Immigrant	8.0%	(3988)	4.6%	(15)		
BMI category					χ^2 = 20.415 (2)	<.001
Normal/underweight (BMI <24.9)	67.8%	(32606)	55.9%	(176)		
Overweight (BMI 25-29.9)	23.4%	(11266)	32.4%	(102)		
Obese (BMI ≥30)	8.8%	(4217)	11.7%	(37)		
Frequency exercise					χ^2 = 4.176 (3)	.243
<1 x/wk	16.8%	(8332)	16.5%	(53)		
1 x/wk	15.8%	(7824)	18.3%	(59)		
2-3 x/wk	43.8%	(21654)	38.8%	(125)		
Almost every day	23.6%	(11660)	26.4%	(85)		
MVPA: 150 min/wk					χ^2 = 0.885 (1)	.192
No	80.5%	(39983)	78.4%	(254)		
Yes	19.5%	(9701)	21.6%	(70)		
Smoking					χ^2 = 2.905 (2)	.234
Yes, daily	1.6%	(796)	2.8%	(9)		
Yes, sometimes	8.5%	(4147)	7.9%	(25)		
No	89.8%	(43652)	89.3%	(284)		

Abbreviation: BMI, body-mass index; MVPA, moderate-intensity and vigorous-intensity physical activity.

our cohort (324/50 054 = 0.65%) was as expected, and in line with the prevalence of 0.65% in the Norwegian population.[26] Also, the different percentage of male vs female students with type 1 diabetes (0.8% vs 0.6%) reflects the difference in incidence as reported in the NCDR.[10] Therefore, a possible selection bias due to over- or underreporting seems unlikely. Related to this issue is the 69% female composition of the sample, which may represent a bias for the overall estimates, as females generally report worse health across most self-

TABLE 2 Diabetes-related characteristics in male and females college and university students with T1D

	Women		Men			Total sample	
	Mean	(SD)	Mean	(SD)	*P*-value[a]	Mean	(SD)
Last HbA1c, % (mmol/mol)	7.86 (62)	1.42 (15)	7.28 (56)	0.94 (10)	<.001	7.65 (60)	1.30 (14)
Age of onset, mean (SD)	11.92	(5.34)	12.04	(6.05)	.853	11.99	(5.60)
Diabetes equipment							
Insulin pen, % (n)	55.1%	(114)	61.0%	(72)	.298	57.2%	(186)
Insulin pump, % (n)	48.8%	(101)	42.4%	(50)	.264	46.5%	(151)
CGM, % (n)	36.7%	(76)	19.5%	(23)	.001	30.5%	(99)
Flash devices, % (n)	8.7%	(18)	14.4%	(17)	.110	10.8%	(35)
How often do you measure your blood sugar? % (n)					.751		
A few times a month/never	4.4%	(9)	6.0%	(7)		5.0%	(16)
Several times a week	8.3%	(17)	9.4%	(11)		8.7%	(28)
Daily	87.4%	(180)	84.6%	(99)		86.4%	(3)
Daily measurements, mean (SD)	5.19	(2.64)	5.22	(2.38)	.911	5.21	(2.55)

Abbreviation: CGM, continuous glucose monitor.
[a]Derived from independent samples *t* tests or Pearson chi-squared tests.

reported health parameters compared to men. Still, as females constitute about 70% of the student population in Norwegian colleges/universities, at least up to a bachelor degree, this should not represent a substantial bias in the current study. Finally, it should be noted that all data in the current study were based on self-reported information, which might result in a social desirability or recall bias.

After categorizing the sample by HbA1c, we see that students with an Hba1c <58 mmol/mol (7.5%) have a rather low mean Hba1c (50 mmol/mol, 6.71%), whereas students with an HbA1c ≥58 mmol/mol (7.5%) have a mean HbA1c of 70 mmol/mol (8.6%). Our cohort seems to contain either very well regulated or quite badly regulated subjects, which is not what we see in the pediatric population.

The overall metabolic control of the students reflected by the mean HbA1c of the study sample was 60 mmol/mol (7.65%). Exercise and smoking habits in students with type 1 diabetes were not different compared to the healthy reference group. However, students meeting the HbA1c target under 7.5% (58 mmol/mol) did reach the MVPA recommendations significantly more often (Table 3). Furthermore, we found a large proportion of overweight and obesity in students with type 1 diabetes (44.1% vs 32.2% in the healthy controls). Students who achieved the HbA1c target of <58 mmol/mol (7.5%) measured their blood sugar more often, had less financial difficulties, a lower BMI, more physical activity and were smoking less. In contrast, those with worse metabolic control (HbA1c >58 mmol/mol, 7.5%) had even higher cardiac risks by being less active, more overweight (54.7%), and smoking (15.2%). The use of technical devices, such as CSII and CGM, was relatively low compared to the pediatric age group of under 18 years, as published recently in the NCDR (CSII: 46.5% vs 77.0%; CGM: 30.5% vs 65%.[10] The use of CGM was not associated with better metabolic control as reflected by lower HbA1c, whereas there was a higher proportion of CSII use in the group not achieving the HbA1c target.

4.1 | Gender aspects

Male students had a much lower mean HbA1c than female students, and reached an HbA1c of <58 mmol/mol (7.5%) in a much higher proportion. However, male students had a much lower usage of CGM compared to female students. While female students are checking their blood glucose as frequent as male students (mean 5.2 times daily), the HbA1c result of the female group was much worse (0.58 pp = 6 mmol/mol). This is critical, as mortality risk increases with HbA1c (2% higher risk for each 1 mmol/mol increase in HbA1c, equating to 12% in our cohort).[27] For the future follow-up of the young female age group, this implicates that clinicians have to make recommendations that are more precise: frequently evaluating the glucose level by either blood glucose measurements or CGM is per se not helpful, as our results show. Former studies were suggesting that the number of measurements per day was inversely associated with HbA1c,[28,29] which apparently is not true for our cohort. Actively targeting toward a normal glucose level and taking insulin, consequently, has to be more in focus, especially in female patients.

4.2 | Lifestyle habits

Students with type 1 diabetes did not have a more active lifestyle than the control group. They had physical activity at least once a week in 83.5% compared to 83.2% in the control group. Frequent training was even less common in students with type 1 diabetes, compared controls (2-3 x/week 43.8% vs 38.8%). However, 73.2% of students with an HbA1c of <58 mmol/mol (7.5%) were training daily, compared to 57% in the group with HbA1c >58 mmol/mol (7.5%). Based on numerous studies, ISPAD recommends regular physical activity in order to avoid micro- and macrovascular complications.[30]

TABLE 3 Demographic and diabetes-related characteristics by A1c treatment goal (58 mmol/mol, 7.5%) among college and university students with T1D

	HbA1c <58 mmol/mol (7.5%)		HbA1c ≥58 mmol/mol (7.5%)		
	Mean/%	(SD/n)	Mean/%	(SD/n)	*P*-value[a]
Demographic characteristics					
Sex					.002
Women	44.2%	(87)	55.8%	(110)	
Men	62.2%	(69)	37.8%	(42)	
Age	22.98	(3.27)	23.00	(3.28)	.959
Marital status					.258
Single	54.1%	(85)	47.7%	(73)	
Married or partner	45.9%	(72)	52.3%	(80)	
Accommodation status					.203
Alone	26.8%	(42)	20.9%	(32)	
With partner	26.1%	(41)	22.2%	(34)	
With friends/collective	41.4%	(65)	45.8%	(70)	
With parents	5.7%	(9)	11.1%	(17)	
Financial difficulties					.030
Never	58.0%	(91)	43.1%	(66)	
Seldom	16.6%	(26)	20.3%	(31)	
Sometimes/often	25.5%	(40)	36.6%	(56)	
Immigrant status					.057
Ethnic Norwegian	51.9%	(153)	48.1%	(142)	
Immigrant	26.7%	(4)	73.3%	(11)	
Health behaviors					
BMI category					.005
Normal/underweight	63.9%	99	45.3%	67	
Overweight	27.1%	42	39.2%	58	
Obese	9.0%	14	15.5%	23	
Frequency exercise					<.001
<1 x/wk	13.4%	21	20.5%	31	
1 x/wk	13.4%	21	22.5%	34	
2-3 x/wk	36.3%	57	41.1%	62	
Almost every day	36.9%	58	15.9%	24	
MVPA: 150 min/wk					<.001
No	70.3%	(130)	87.4%	(146)	
Yes	29.7%	(55)	12.6%	(21)	
Smoking					.026
Daily	1.3%	2	4.6%	7	
Sometimes	4.5%	7	10.6%	16	
No	94.2%	145	84.8%	128	
Diabetes-related characteristics					
HbA1c % value, mean (SD)	6.71	(0.55)	8.60	(1.14)	<.001
Age of onset, mean (SD)	12.86	(5.79)	11.11	(5.25)	.006
Diabetes equipment					
Insulin pen, % (n)	62.4%	(98)	52.3%	(80)	.071
Insulin pump, % (n)	39.5%	(62)	54.9%	(84)	.007
CGM, % (n)	28.0%	(44)	35.3%	(54)	.169

(Continues)

TABLE 3 (Continued)

	HbA1c <58 mmol/mol (7.5%)		HbA1c ≥58 mmol/mol (7.5%)		
	Mean/%	(SD/n)	Mean/%	(SD/n)	*P*-value[a]
Flash devices, % (n)	13.4%	(21)	9.2%	(14)	.240
How often do you measure your blood sugar? % (n)					.001
A few times a month/never	2.5%	(4)	7.8%	(12)	
Several times a week	4.5%	(7)	13.7%	(21)	
Daily	93.0%	(146)	78.4%	(120)	
Daily measurements, mean (SD)	5.30	(2.64)	5.14	(2.51)	.612

Abbreviations: BMI, body-mass index; CGM, continuous glucose monitor; MVPA, moderate-intensity and vigorous-intensity physical activity.
[a]Derived from independent samples *t* tests or Pearson chi-squared tests.

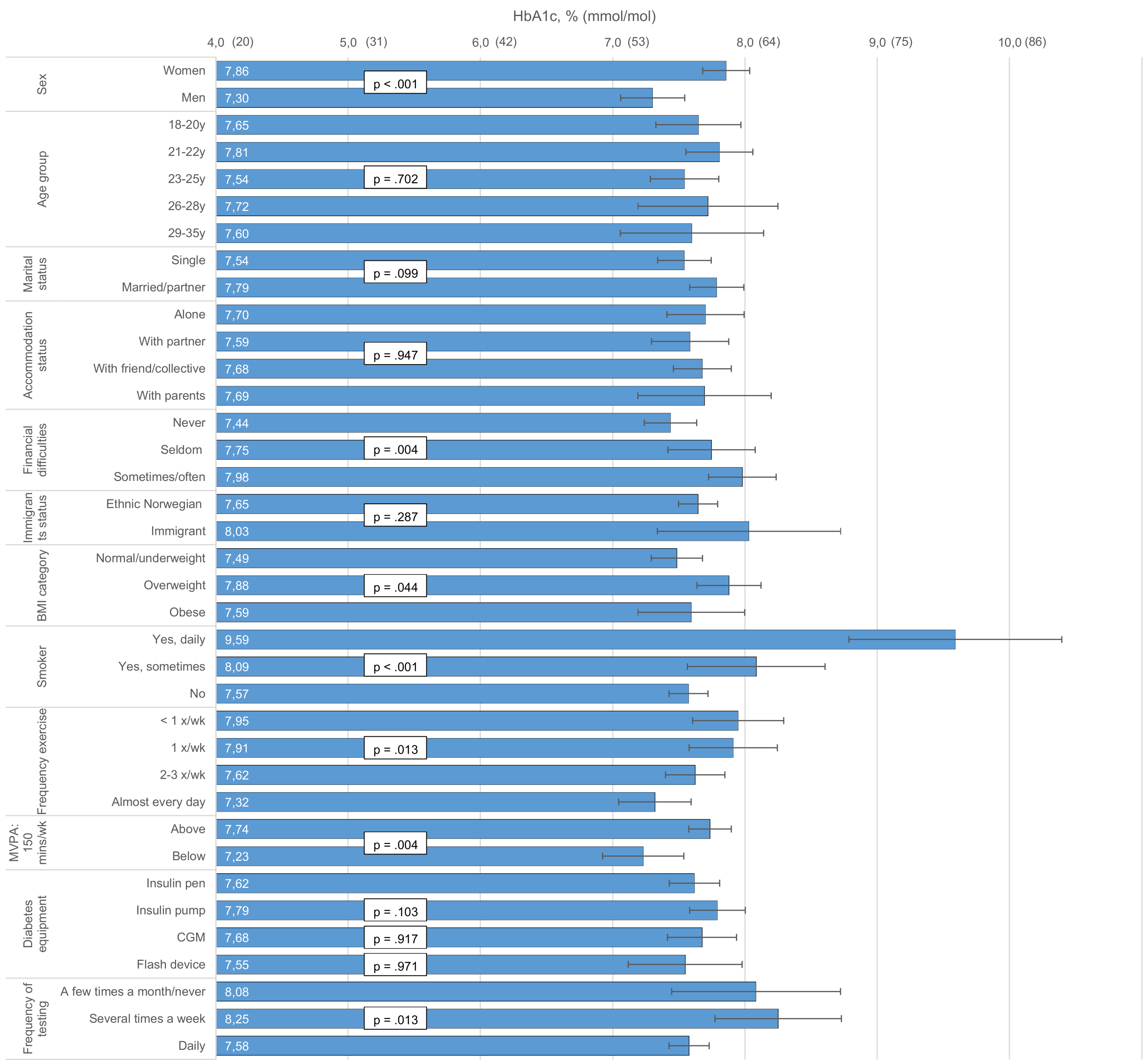

FIGURE 1 Estimated marginal means of HbA1c adjusted for age at diabetes onset and sex) by demographic factors, lifestyle behaviors and diabetes-related characteristics. Note: p-values are based on overall Chi-squared tests, except for “Diabetes equipment” (which are compared to not using that specific device [as the responses were not mutually exclusive])

Moy et al showed that the activity level is inversely associated with mortality risk,[31] and Tikkanen et al showed that exercise, particularly high frequency and high intensity exercise, may reduce the risk of cardiovascular disease (CVD) events in patients with type 1 diabetes.[32] De Lima et al showed that teenagers with type 1 diabetes had less physical activity and less cardiorespiratory capacity than healthy controls. Those teenagers with lower BMI *z*-score, who dedicated a greater time in moderate-to-vigorous intensity physical activity, demonstrated better glycemic control.[33] Our data suggests that clinicians still can improve in encouraging their young patients to regular physical activity, at least three times a week. However, smoking seems to be a key confounder when evaluating the potential benefits of physical activity, and physical activity alone might not be as powerful in preventing cardiovascular risks as formerly thought (27).

4.3 | Smoking

Unfortunately, 2.8% of the students with type 1 diabetes were smoking daily, compared to only 1.6% in controls (P = .234). Students with a higher HbA1c (>58 mmol/mol (7.5%)) were smoking daily in 4.6%, while only 1.3% did in the group with good metabolic control (P = .026). Thus, compared to international data, these rates are still rather low. Reynolds et al reported data from the American SEARCH study, with a prevalence of smoking of 2.7%/17.1%/34% smoking in the age groups of under 15, 15 to 19, and over 19 years of age, respectively. Less than 50% of youth aged 10 to 14 years (52.2% of participants) reported having ever been counseled by their healthcare provider not to smoke or to stop smoking (27). Hofer et al showed a high prevalence of smoking of 5% already in the 11- to 15-year-old age group, and 28.4% in the 15- to 20-year-old age group. The HbA1c was 76 mmol/mol (9.1%) in smoking young with type 1 diabetes compared to 8.0% (64 mmol/mol) in nonsmokers. Both our own data, but also the results from these studies confirm the high urgency of both regularly asking for smoking habits, but also educating on the severe consequences of smoking for subjects with type 1 diabetes, in order to prevent adolescents from smoking. When recognizing a newly developed smoking habit, smoking cessation should be addressed by the clinician, and supportive measures should be recommended and offered. Still, there is very limited evidence on the effect of smoking-cessation interventions in the adolescent age group,[34] and we might need to learn better ways of addressing smoking.

4.4 | Overweight and obesity

Among students with type 1 diabetes, overweight and obesity were more common than in healthy controls. Students with type 1 diabetes and high HbA1c were more often overweight and obese, compared to students with HbA1c <58 mmol/mol (7.5%). The relation between BMI and CVD has been shown by numerous studies.[35] In addition, Csiege et al have recently described the association between suboptimal controlled HbA1c and obesity in a large study on adults with type 1 diabetes (26). In contrast, Rawshani et al evaluated the relative prognostic importance of different risk factors for mortality and cardiovascular events, and showed that BMI was not within the most important causes of death. However, their cohort had a BMI of approximately 25 kg/m^2 in all HbA1c groups.[27] This differs significantly from both our cohort and the results from Csiege (2018) mentioned above. We believe that monitoring BMI regularly, and adjusting insulin treatment and lifestyle recommendations in order to prevent overweight in youth with type 1 diabetes, is still of major importance for the prevention of CVD.

The cohort of our study is a privileged group of young adults, living and studying in a wealthy western country, and thereby not comparable to any general population. One would wish and expect that subjects with type 1 diabetes in this special cohort showed a healthier lifestyle, compared to subjects without diabetes as a risk factor. It is concerning to see the lacking or inadequate physical activity, high proportion of overweight and obesity, smoking habits, and difference in HbA1c related to gender. In female students, frequent measuring of blood glucose does not translate into better HbA1c. The use of CSII or CGM was not associated with a better metabolic control as reflected by lower HbA1c. Our results supply valuable information for clinicians taking care of youth and young adults with type 1 diabetes. The follow-up of this age group should be adapted in order to reach better glucose control and healthier lifestyle habits, especially in the female subjects. However, the effective strategies to reach these goals have still to be explored.

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AUTHOR CONTRIBUTIONS

Børge Sivertsen is the guarantor of this work and, as such, had full access to all the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis. Heiko Bratke and Børge Sivertsen took the initiative for the study. Børge Sivertsen is responsible for the collection of the data in SHoT2018. Heiko Bratke, Kari Jussie Lønning, and Børge Sivertsen contributed to the analysis and interpretation of the data, and the manuscript development, vouch for the accuracy and completeness of the data reported, and made the decision to submit the manuscript for publication. Heiko Bratke, Kari Jussie Lønning, and Børge Sivertsen finally approve this version to be published.

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