

Obesity in Switzerland: do estimates depend on how body mass index has been assessed?

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Summary

Background/aim: In Switzerland monitoring of obesity in the general population is based on body mass index (BMI) derived from self-reported weight and height. This approach may lead to misclassification of obese subjects and misinterpretation of obesity prevalence and trends. In order to explore this potential bias, we compared studies with measured and self-reported data.

Methods: We analysed five studies based on measured BMI and five studies based on self-reported BMI, all of which were carried out in Switzerland between 1977 and 2004 and encompassed men and women aged 35–74 years. Obesity was defined as BMI ≥ 30 kg/m².

Results: The prevalence of obesity was markedly higher (1.6 times) in studies with measured BMI in both sexes: 14.2% vs 8.8% in men and 12.5% vs 7.9% in women. These differences tended to increase with age in both sexes. However, a similar upward trend in the prevalence of

obesity was observed with both methods (absolute increase per year in men and women respectively: 0.24% and 0.25% using measured BMI vs 0.17% and 0.20% using self-reported BMI).

Conclusion: In Switzerland obesity prevalence in adults has clearly increased in the past three decades. Although the use of self-reported height and weight leads to a valid estimation of this increase, it results in a considerable underestimation of obesity prevalence rates in Switzerland. The type of assessment of height and weight should be taken into consideration when comparing prevalences of obesity between studies or regions or when using these prevalences to assess associated health risks or costs.

Key words: trends; prevalence; obesity; body mass index; measured and self-reported weight and height; surveys; Switzerland

Introduction

In Switzerland obesity-related monitoring, health policy and cost estimates are generally based on prevalence derived from the Swiss Health Survey (SHS) [1, 2]. These figures are often compared with those found in international studies. Such comparisons may be misleading, since the SHS relies on reported data obtained through telephone interviews, whereas other data, namely from the US NHANES studies [3], are based on measurements of height and weight. When participants are asked about their height and weight, they usually tend to underreport weight and to overreport height, thus leading to underestimation of their actual BMI [4–6]. Thus, using BMI based on self-reported data to assess health risk may lead to misclassification bias and distort the relationship between obesity and disease or death [7]. The magnitude of this misclassification bias differs significantly between and

within populations [4–6]. In Switzerland this issue has been evaluated only on a small sample [8].

One major goal of monitoring is correct assessment of trends in the population's health, including obesity. At present, little is known in Switzerland as to whether obesity trends differ when self-reported or measured data are used.

Thus, our aim was to evaluate the validity of BMI based on self-reported data as an estimator of obesity prevalence and trends in Switzerland. We compared the prevalence of obesity obtained from studies performed in the past three decades based on measured BMI with that from surveys deriving BMI from self-reported height and weight and carried out during the same time period.

Participants and methods

Data collection

All studies were carried out in population-based samples of the Swiss population between 1977 and 2004 (measured height and weight) and between 1980 and 2002 (self-reported height and weight).

Measured height and weight were obtained from five studies carried out in Switzerland: NRP 1A (National Research Project 1A) study [9], the three MONICA stud-

ies (MONItoring of Trends and Determinants in Cardiovascular Disease) [10] and the CoLaus study (Cohorte Lausannoise) [11]. French-speaking Switzerland was represented in all five, the Italian-speaking part in four studies and the German-speaking part in one study. To the best of our knowledge all population-based studies with measurements carried out during that period were included, with the exception of a study conducted in

Table 1

Main characteristics of the study populations (restricted to ages 35–74).

Study name	Coverage	Participation	Sample size	Study year	Birth year*	Men		Women	
						Excluded*	Included	Excluded*	Included
NRP 1a	5 cities (Aarau Solothurn Nyon Vevey Lugano)	59%	5150	1977–78	1928	0	2375	2	2773
MONICA 1	3 cantons (VD FR TI)	57%	2998	1984–85	1936	8	1515	3	1472
MONICA 2	3 cantons (VD FR TI)	61%	2975	1988–89	1939	2	1528	2	1443
MONICA 3	3 cantons (VD FR TI)	53%	2842	1992–93	1943	3	1381	0	1458
CoLaus	City of Lausanne	42%	6188	2003–04	1951	1	2936	2	3249
All measured			20153		1939	14	9735	9	10395
SOMIPOPS	Switzerland	73%	2810	1980–84	1932	24	1427	37	1322
IGIP	5 cantons (ZH BE VD GE TI)	70%	1548	1987–89	1936	3	680	13	852
SHS 1	Switzerland	71%	8983	1992–93	1941	46	3977	126	4834
SHS 2	Switzerland	60%	7662	1997	1946	19	3350	47	4246
SHS 3	Switzerland	64%	13159	2002	1949	32	5950	88	7089
All self-reported			34162		1944	124	15384	311	18343

* Median, * Exclusion due to missing values of weight or height or (n = 9) due to height <120 cm.

NRP 1A: National Research Project 1A [9]; MONICA: MONItoring of Trends and Determinants in Cardiovascular Disease [10]; CoLaus: Cohorte Lausannoise [11]; SOMIPOPS: SOcio-Medical Indicators for the POPulation of Switzerland [13]; IGIP: Interkantonaes GesundheitsIndikatorenProjekt [14]; SHS: Swiss Health Survey [1]. VD: Vaud; FR: Fribourg; TI: Ticino; ZH: Zurich; BE: Bern; GE: Geneva.

Table 2

Mean (%) height, weight and BMI by year of birth and type of assessment (self-reported vs measured data).

Year of birth*	Height			Weight			BMI		
	Reported	Measured	Difference	Reported	Measured	Difference	Reported	Measured	Difference
Men									
1910–19, n = 1048	172.2	169.8	2.4	75.9	75.8	0.1	25.6	26.3	-0.7
1920–29, n = 3306	173.1	171.3	1.8	77.6	78.8	-1.2	25.9	26.9	-1.0
1930–39, n = 5909	173.7	172.3	1.4	78.6	78.7	-0.1	26.0	26.5	-0.5
1940–49, n = 6624	175.0	173.5	1.5	78.3	79.3	-1.0	25.6	26.3	-0.7
1950–59, n = 5248	176.3	175.2	1.1	77.9	79.7	-1.8	25.0	25.9	-0.9
1960–69, n = 2784	177.4	176.8	0.6	78.2	80.1	-1.9	24.8	25.6	-0.8
All	175.0	173.1	1.9	78.1	78.9	-0.8	25.5	26.3	-0.8
Women									
1910–19, n = 1260	161.9	158.8	3.1	64.5	64.7	-0.2	24.6	25.7	-1.1
1920–29, n = 4157	162.5	159.6	2.9	65.3	65.3	0.0	24.8	25.7	-0.9
1930–39, n = 6817	163.1	160.7	2.4	65.7	65.0	0.7	24.7	25.2	-0.5
1940–49, n = 7611	163.8	161.7	2.1	63.6	64.3	-0.7	23.7	24.6	-0.9
1950–59, n = 5679	164.3	163.0	1.3	61.6	64.0	-2.4	22.8	24.1	-1.3
1960–69, n = 2886	165.4	164.3	1.1	61.9	64.4	-2.5	22.6	23.9	-1.3
All	163.7	161.2	2.5	63.7	64.7	-1.0	23.8	24.9	-1.1

* Exclusion of 528 individuals with year of birth <1910 and >1970

Results are expressed as mean values (%). BMI: body mass index. NRP 1A: National Research Project 1A [9]; MONICA: MONItoring of Trends and Determinants in Cardiovascular Disease [10]; CoLaus: Cohorte Lausannoise [11]; SOMIPOPS: SOcio-Medical Indicators for the POPulation of Switzerland [13]; IGIP: Interkantonaes GesundheitsIndikatorenProjekt [14]; SHS: Swiss Health Survey [1].

Figure 1

Distribution of BMI in all studies with measured (black) and self-reported (grey) BMI, by sex.

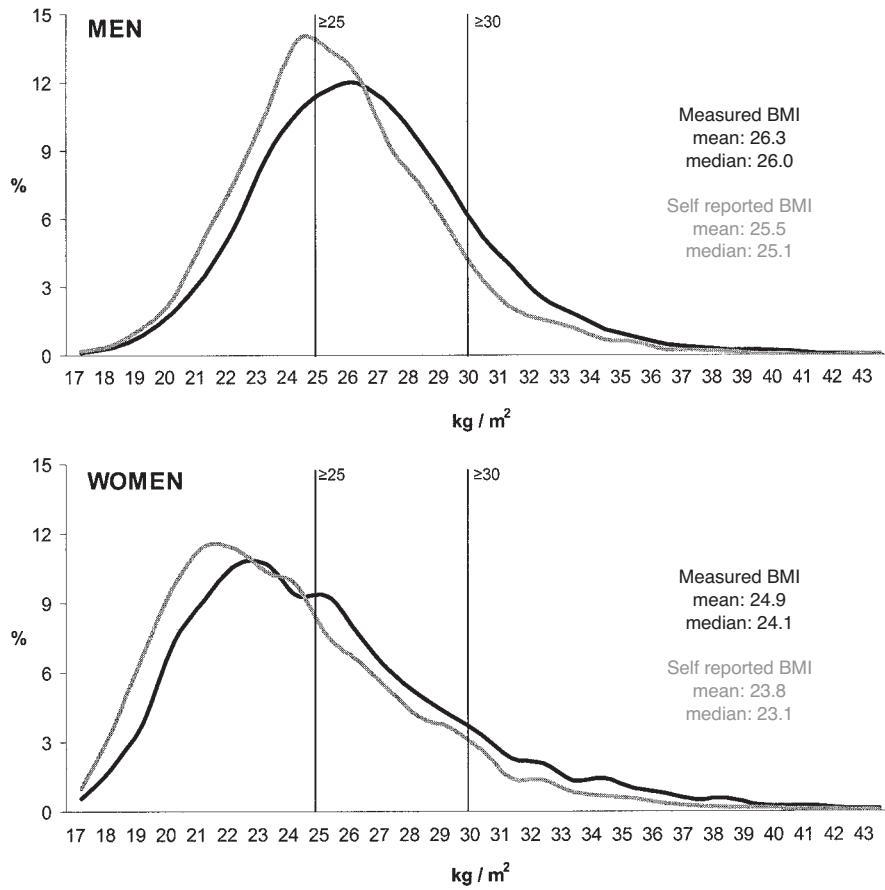
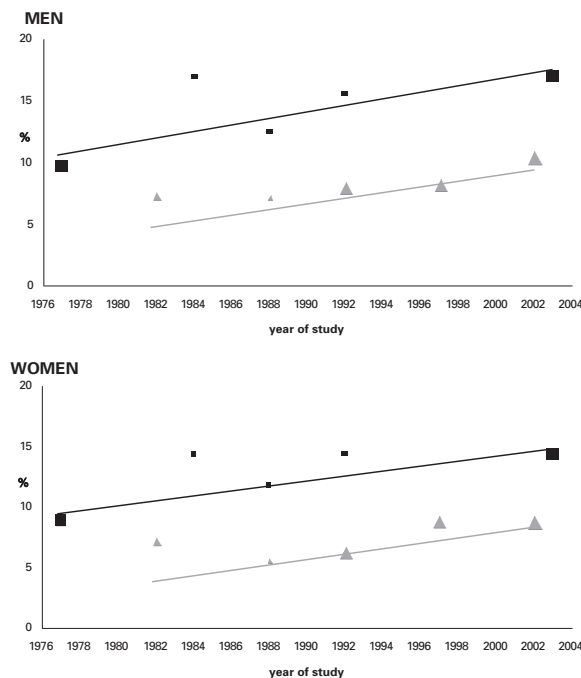


Figure 2

Mean (%) prevalence of obesity by study (measured: black; self-reported: grey) in men and women. Trend lines were obtained by linear regression. The studies included are: 1977–78: NRP 1A (National Research Project 1A [9]); 1984–1993: MONICA (MONItoring of Trends and Determinants in CArdiovascular Disease [10]); 2003–04: CoLaus (Cohorte Lausannoise [11]); 1980–1984: SOMIPOPS (SOCio-Medical Indicators for the POPulation of Switzerland [13]); 1987–89: IGIP (Interkantonaales GesundheitsIndikatorenProjekt [14]); 1992–2002: SHS (Swiss Health Survey [11]).



Geneva [12] for which the data were not available for this analysis. In all studies weight and height were measured by standardised procedures.

Self-reported height and weight were obtained from five population-based health surveys carried out in Switzerland: SOMIPOPS (SOCio-Medical Indicators for the POPulation of Switzerland) [13], IGIP (Interkantonaales GesundheitsIndikatorenProjekt) [14] and the three Swiss Health Surveys (SHS) [1]. In SOMIPOPS weight and height were reported by self-administered

questionnaire whereas in IGIP and in all SHS weight and height were assessed by telephone interview.

In all studies weight was recorded in kg and height in cm. Body mass index (BMI) was calculated as weight divided by height squared (kg/m²) and obesity was defined as BMI ≥ 30 kg/m².

Statistical analysis

All analyses were performed with Stata 9.2 (Stata Corp, Texas, USA). Since only the 35–74 age range was represented in all studies, we restricted our analysis to individuals of that age range. We also excluded individuals with missing weight or height (n = 449 for all studies included), or with height <120 cm (n = 9 for all studies included). During the 20th century height and weight increased in the Swiss population with each generation (ie children became taller than their parents). These secular trends can be accounted for when analysing height and weight by year of birth. The mean values were compared between the two types of assessment and are presented in table 2. Results were expressed as mean BMI or as frequency of obesity.

The prevalence of obesity was calculated separately for each sex and assessment type (self-reported or measured). Trend lines by type of assessment and sex were calculated including all studies using linear regression. Different sample size of the studies was accounted for.

Since we did not consider clustering within studies in our analysis, no confidence intervals are provided. As the data from the different studies include both Swiss and foreign citizens, no weight or age standardisation was performed. The results obtained after excluding foreign citizens and standardising to the Swiss population (1990 census) differed only marginally from the unadjusted ones (not shown).

Results

Study characteristics

The main characteristics of the study populations are summarised in table 1. Both assessment types covered similar time periods (measured: 1977–2004; self-reported: 1981–2002). The number of participants was more than twice as large in the self-reporting group as in the group with measurements. The proportion of excluded persons was higher in self-reporting studies (1.3% *vs* 0.1%).

Height, weight and BMI

Table 2 shows pooled height, weight and BMI in both assessment types. Using year of birth instead of age allowed us to account for secular trends in height. The difference between measured and self-reported height was greater in women than men and in older than in younger persons. The difference in weight was slightly greater in women than men and in younger than in older persons.

Figure 1 illustrates the aggregated distribution of BMI by type of assessment. In men, the distribution was close to Gaussian, particularly for measured BMI. Conversely, in women the distribution was flatter and more right-skewed. In both sexes, the kurtosis was larger in studies with self-reported than with measured BMI (12.0 *vs* 5.0 in men and 6.9 *vs* 5.3 in women); however, the largest absolute difference between measured and self-reported BMI was found in the range 27–32 kg/m² (men) and 18–22 kg/m² (women).

Prevalence of obesity

The increase in prevalence of obesity over time by study and type of assessment (measured or self-reported) is shown in figure 2. The relatively small differences between measured and self-reported mean BMI (0.8 in men, 1.1 in women) reported in table 2 translated into a large difference in prevalence of obesity in both sexes. This difference was fairly constant over time. Hence, similar paces of increasing prevalence of obesity were observed using self-reported (absolute annual increase: 0.17% in men and 0.20% in women) or measured BMI (absolute increase: 0.24% in men and 0.25% in women). The pooled prevalence of obesity was significantly higher in studies with measured BMI than in those based on self-reporting: 14.2% *vs* 8.8% in men and 12.5% *vs* 7.9% in women. In both sexes the prevalence of obesity was 1.6 times higher in studies using measured BMI than in studies using self-reported BMI. Using BMI ≥ 35 kg/m² instead of BMI ≥ 30 kg/m² as cut-off showed a 1.6 (men) and 2.1 (women) times higher prevalence in self-reported than in measured data.

Age-specific prevalences of obesity based on measured and self-reported BMI are presented in table 3 (by study and pooled results). The differences in obesity prevalence vary widely within and between studies. The overall differences between the two assessment types were smaller between 35–44 years than in older age groups. In most studies the prevalences of obesity in men and women were comparable, particularly in studies based on self-reports.

Table 3

Prevalence (%) of obesity in studies with measured and self-reported BMI by sex.

Assessment	Measured						Self-reported					
	Year	1977	1984	1988	1992	2003	1977–2003	1981	1989	1992	1997	2002
Study	NRP 1a	MONICA 1	MONICA 2	MONICA 3	COLAUS	All measured	SOMIPOPS	IGIP	SGB 1	SGB 2	SGB 3	All self-reported
Men												
35–44y	4.4	12	8.2	11	11	9.1	4.4	3.7	5.4	4.6	6.5	5.5
45–54y	12	19	11	18	15	15	8.0	4.9	7.7	8.0	12	9.1
55–64y	14	22	17	15	22	19	8.8	9.1	11	12	13	12
65–74y	14	19	20	30	23	20	11	12	9.2	11	13	11
35–74y	10	17	12	16	17	14	7.3	7.2	7.9	8.1	10	8.8
Women												
35–44y	4.4	7.1	5.5	7.3	10	6.8	4.0	1.8	3.7	4.9	5.8	4.8
45–54y	8.1	17	12	13	14	13	6.8	6.4	5.5	6.8	8.5	7.0
55–64y	13	22	17	24	17	18	10	8.6	8.6	13	9.9	10
65–74y	14	18	22	20	17	17	11	6.6	8.7	13	12	11
35–74y	8.9	14	12	14	14	13	7.2	5.7	6.3	8.8	8.8	7.9

Results are expressed as mean values. BMI: body mass index. NRP 1A: National Research Project 1A [9]; MONICA: MONItoring of Trends and Determinants in CArdiovascular Disease [10]; CoLaus: Cohorte Lausannoise [11]; SOMIPOPS: SOcio-Medical Indicators for the POPulation of Switzerland [13]; IGIP: Interkantonaes GesundheitsIndikatorenProjekt [14]; SHS: Swiss Health Survey [1].

Discussion

We used data from ten Swiss population surveys performed in the past three decades with self-reported or measured BMI to evaluate the difference in obesity estimates between the two assessment methods. Mean BMI was about 1 kg/m² higher when BMI was measured relative to self-reported estimates, leading to a 1.6 times higher prevalence of obesity in studies with measured BMI compared to those with self-reported data. However, both methods showed that obesity prevalence has clearly increased at a similar rate during the past three decades in Switzerland.

Increasing prevalence of obesity in Switzerland

The consistency of the trends by both methods strongly suggests that the increase in obesity prevalence in Switzerland during the past 30 years is real. The magnitude of the increase seems quite similar regardless of the method. This suggests that it is not unreasonable to use the SHS to observe general trends of obesity in the Swiss population.

Height, weight and BMI

Taking all studies together, the overestimation of height was 1.9 cm in men and 2.5 cm in women. In other general populations differences of 0.5–2.3 cm (men) and of 0–2.2 cm (women) were reported [4]. Our figures for height overestimation can thus be considered fairly large. In our comparison the overall difference between self-reported and measured weight was –0.8 kg in men and –1.0 kg in women. This is in line with differences found in other general populations (0.4 to –1.9 kg in men and 0.7 to –1.6 kg in women) [4].

The reasons for differences between self-reported and measured estimates are multiple. For instance, many men may have reported their height as measured decades before during military service and have thus overestimated their current height. Still, in this study the magnitude of height overestimation was higher in women than men in all age groups, while a small gender difference was found regarding weight estimation. This contrasts with studies showing that men are more likely to overestimate their height whereas women are more likely to underestimate their weight [4–6, 15]. The greater overestimation of height in older than in younger individuals found in both genders is in line with other findings [5, 15], just as underestimation of weight was more frequent in younger than in older individuals [5, 15]. Compared to younger people the elderly may be less susceptible to rapid weight gain but more prone to shrinking, a process which increases/accelerates with age [5, 15, 16]. In our study older women overestimated their height to a greater degree than older men, as could be expected in view of the more pronounced de-

crease in height after menopause. However, among perimenopausal US women self-reported current height was found to be accurate [17].

The tendency to underreport weight and/or to overreport height may also increase with the participant's BMI, resulting in higher relative differences in the prevalence of persons with BMI ≥ 35 kg/m² than of those with BMI ≥ 30 kg/m² [5]. Indeed, in women (but not in men), the prevalence of individuals with BMI ≥ 35 kg/m² was more than twice as high in measuring as in self-reporting studies (*vs* 1.6 times higher for BMI ≥ 30 kg/m²).

The difference between self-reported and measured BMI appears relatively constant over time. This is somewhat surprising since it might be expected that social pressure to maintain a slim figure would result in greater underestimation of weight in recent studies compared to older ones (ie increasing social desirability bias towards low body weight). However, since the differences were quite systematic and constant, it may be concluded that the propensity of survey participants to misreport their height and weight did not change over time. Also, contrary to others [15], we found no significant differences in the distribution pattern of self-reported weight and height when assessed by self-administered questionnaire (SOMIPOPS) or by telephone interview (four other surveys with self-reported data).

In the pooled analysis overestimation of height and underestimation of weight due to self-reporting resulted in a lower BMI in men (–0.8 kg/m²) and women (–1.1 kg/m²) relative to measured data. This difference is within the range reported in a systematic review (–0.2 to –1.8 kg/m²) [4] and almost equal to that indicated in a study comparing reported and measured weight and height in the same individuals (–0.9 kg/m² in men and –1.1 kg/m² in women) [5]. Although in our study the difference in mean BMI between the two assessment types was greater in women than in men, this did not result in a wider difference in obesity prevalence in women than in men. This apparent paradox is explained by figure 1: values around the cut-off of 30 kg/m² are considerably more frequent in men than in women; this means that more men than women have a measured BMI slightly above 30 kg/m² and thus would be misclassified as non-obese using self-reported BMI. In both sexes the relatively minor difference in mean BMI between self-reported and measured estimates resulted in a marked difference in obesity prevalence. In fact, a small measurement deviation in a continuous variable may lead to wide differences in the prevalence of derived categories [18]. Differences in mean BMI between populations can thus be misleading since they furnish only limited information on the prevalence of overweight or obesity.

Misclassification due to self-report

The prevalence of obesity was consistently lower in surveys with self-reported data irrespective of sex and age group. These findings are in agreement with others [4–6, 15]. In our samples a bias of this kind leads to misclassification of 60% of (measured) obese individuals. This misclassification may lead to overestimation of the risk of obesity-related death or disease [7]. This fact is only rarely considered in studies investigating risk associated with obesity prevalences obtained by self-reporting [19], and should be borne in mind when dichotomising patients into “obese” and “non-obese”.

Limitations

Several limitations need to be considered. First, the studies included were somewhat heterogeneous as regards persons and populations (uneven geographical coverage, lack of German-speaking participants in four out of five studies with measured data). However, data from the three SHS showed only a marginal difference in mean BMI between the German-, French- and Italian-speaking regions. Moreover, this absence of significant differences in mean BMI between the linguistic regions is characteristic of all three health surveys. Thus, it is somewhat improbable that the under-representation of German-speaking regions found in most studies might have led to biases regarding BMI distribution or the preva-

lence of obesity. Secondly, the MONICA studies had a relatively large proportion of participants from the Italian-speaking part of Switzerland compared to the other studies. Since participants from the Italian-speaking region are significantly shorter than those from the French-speaking region, the average height in these studies is below the national average. Still, if weight follows a similar pattern this should not influence mean BMI levels or prevalence of obesity. Thirdly, pooling studies may cause problems since the age and sex distribution of participants varied significantly. However, we conducted a separate analysis after excluding foreign participants and adjusting for age using the 1990 census as a standard population. The resulting prevalence rates of obesity differed only marginally from the non-adjusted estimates. Hence, to avoid arbitrary decisions for pooling, we decided not to use them. A further statistical limitation is that we did not consider clustering within studies (ie that participants have more common characteristics within studies than they would have by chance) by using a mixed model. Considering clustering in the data would however only affect confidence intervals (thus not shown) but not point estimates. Finally, non-participants may be more frequently obese than participants [20]. Since participation rates varied between studies, the difference in obesity prevalence estimates between studies using self-reported and measured BMI may be biased.

Conclusion

Obesity has rapidly increased in the past three decades in Switzerland, irrespective of the assessment method used. However, studies using self-reported BMI considerably underestimated obesity prevalence. Also, obesity prevalence based on the common cut-off value of 30 kg/m² is very sensitive to small shifts in frequency distribution, especially in men. This limitation should be borne in mind, especially since it could also result in overestimation of the risk associated with obesity [7, 19]. Nevertheless, trends in obesity prevalence in populations may be validly captured using self-reported BMI. Because over- and underreporting appears to be quite systematic, correction factors using separate adjustment factors for weight and height (independently of sex and possibly age) could increase the accuracy of self-reported estimates [15]. Finally, the major increase in obesity prevalence in Switzerland underlines the need for more forceful nationwide public health intervention.

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