

## **Body mass index: comparing mean values and prevalence rates from telephone and examination surveys**

*Épidémiologie de l'excès de poids : comparaison des estimations obtenues par enquête téléphonique et par enquête avec examen physique*

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*Background: Cost effective means of assessing the levels of risk factors in the population have to be defined in order to monitor these factors over time and across populations. This study is aimed at analyzing the difference in population estimates of the mean levels of body mass index (BMI) and the prevalences of overweight, between health examination survey and telephone survey.*

*Methods: The study compares the results of two health surveys, one by telephone (N=820) and the other by physical examination (N=1318). The two surveys, based on independent random samples of the population, were carried out over the same period (1992-1993) in the same population (canton of Vaud, Switzerland).*

*Results: Overall participation rates were 67% and 53% for the health interview survey (HIS) and the health examination survey (HES) respectively. In the HIS, the reporting rate was over 98% for weight and height values. Self-reported weight was on average lower than measured weight, by 2.2kg in men and 3.5kg in women, while self-reported height was on average greater than measured height, by 1.2cm in men and 1.9cm in women. As a result, in comparison to HES, HIS led to substantially lower mean levels of BMI, and to a reduction of the prevalence rates of obesity (BMI>30kg/m<sup>2</sup>) by more than a half. These differences are larger for women than for men.*

*Conclusion: The two surveys were based on different sampling procedures. However, this difference in design is unlikely to explain the systematic bias observed between self-reported and measured values for height and weight. This bias entails the overall validity of BMI assessment from telephone surveys.*

*Health survey. Validity. Weight. Height. BMI.*

*État de la question : Des méthodes fiables et peu coûteuses sont nécessaires pour établir la distribution des facteurs de risque cardio-vasculaires au sein d'une population et suivre leur évolution dans le temps. Les données peuvent être obtenues par des enquêtes téléphoniques (ET) ou par des enquêtes avec examen physique des participants (EEP). Le but de cette étude est de comparer les estimations obtenues selon ces deux méthodes pour la valeur moyenne et la distribution de l'indice de masse corporelle (IMC = indice de masse corporelle = poids divisé par la taille au carré).*

*Méthodes : L'étude compare les résultats de deux enquêtes, une ET (n = 820 ; participation : 67 %) et une EEP (n = 1318 ; participation : 53 %), basées sur des échantillons aléatoires de la population*

adulte et réalisées indépendamment pendant la même période (1992-1993) dans une même région (canton de Vaud, Suisse).

*Résultats* : Dans l'ET, 98 % des participants ont déclaré leur poids et leur taille. Par rapport à l'EEP, le poids moyen obtenu par l'ET était inférieur de 2,2 kg chez les hommes et de 3,5 kg chez les femmes. À l'inverse, pour la taille, le niveau moyen obtenu par l'ET était supérieur de 1,2 cm et de 1,9 cm, respectivement, à la taille mesurée dans l'EEP. Il en résulte une sous-estimation de l'IMC moyen, ainsi qu'une sous-estimation des fréquences de l'excès pondéral (IMC > 25) et de l'obésité (IMC > 30). Cette sous-estimation dépassait souvent 50 % dans l'ET par rapport à l'EEP.

*Conclusion* : Les deux enquêtes étaient basées sur des plans d'échantillonnages différents. Cependant, cette différence n'explique pas le biais systématique observé entre valeurs déclarées et mesurées pour le poids et la taille. Ce biais compromet la validité des enquêtes téléphoniques pour estimer l'étendue des problèmes d'obésité au sein d'une population.

Enquête de santé. Validité. Poids. Taille. IMC.

## INTRODUCTION

Monitoring the prevalence of established risk factors for diseases is essential in developing preventive strategies in public health. Relevant indicators can be gathered in various manners, including ad hoc measurement (examination survey) and self-reported values (e.g., by telephone survey). Health examination surveys provide objective measures, although the validity of figures is often limited by low participation rates; furthermore, health examination requires a complex infrastructure and a corresponding cost. Telephone surveys are a suitable alternative for gathering information, because the widespread availability of the telephone in developed countries allows a reasonable sampling frame at relatively low cost. Furthermore, telephone surveys can be performed rapidly. On the other hand, self-reported data are considered less valid [1] because they are dependent on the awareness of the respondents.

This study takes the opportunity of two surveys conducted independently during the same period, one by direct examination, the other by telephone interview, to compare prevalence of health indicators related to height and weight.

## METHODS

Data from one south-western Swiss Canton (Vaud, about 600.000 habitants in 1993) are presented here. Two independent surveys were compared: a Health Examination Survey (HES) conducted within the framework of the MONICA project devoted to cardiovascular risk factors [2], and a Health Interview Survey (HIS) conducted within the framework of a federal project aimed at the overall monitoring of health-related risk factors with a telephone survey [3].

The methods of data collection of HES have been described elsewhere [4, 5], but are summarized here. A representative sample of the resident population aged 25 to 74 years was drawn with a two-stage sampling method [6]. Firstly, a sample was drawn with 33 out of the 385 communes of the Canton, after stratification according to their number of residents. Secondly, a random sample of the residents was drawn from the population files in each selected commune. All residents were included, including those living in institutions. The overall participation rate was 53% (1,318 respondents). Height and weight were measured with participants standing without shoes and heavy outer garments. Methods related to HIS have been described previously [3]. A direct random sample has been drawn from the telephone list. Only residents speaking French, German or Italian and living in the community were included in the sample. Eight hundred and twenty persons were interviewed, representing a participation rate of 67%. Among others, questions were asked on weight ("what is your weight approximately?") and height ("what is your height, without shoes?").

This paper analyzes the mean values of weight, height and BMI, as well as the prevalence of overweight (BMI>25kg/m<sup>2</sup>) and obesity (BMI>30kg/m<sup>2</sup>) according to gender and age (10 year groups).

## RESULTS

Participation rate in HES is lower than that observed in HIS (53% and 67%, respectively). Participation in HES is similar in both gender; it changes with age (between 40 and 60%), with a maximum in middle-aged subjects. Participation rates in HIS according to gender and age are not available.

In HIS, reporting was almost complete for weight and height (more than 98%, data not shown).

According to *table I*, the mean weight is always lower in HIS than in HES in both genders. The difference is larger among women (between 1.5 and

TABLE I. — Mean values of weight, height and BMI according to survey, age and gender. Vaud, 1992-93.

	Weight (kg)			Height (cm)			BMI (kg/cm <sup>2</sup> )		
	HES <sup>a</sup>	HIS <sup>b</sup>	Diff	HES <sup>a</sup>	HIS <sup>b</sup>	Diff	HES <sup>a</sup>	HIS <sup>b</sup>	Diff
Men age									
25-34	76.1	75.9	0.2	177.0	178.0	-1.0	24.2	23.9	0.3
35-44	79.6	75.8	3.8	176.1	175.7	0.4	25.9	24.5	1.4
45-54	80.9	78.0	2.9	174.1	175.9	-1.8	26.8	25.1	1.7
55-64	81.3	80.1	1.2	174.3	174.8	-0.5	27.0	26.2	0.8
65-74	79.4	78.3	1.1	169.9	173.4	-3.5	28.1	26.0	2.1
Women age									
25-34	61.1	57.0	4.1	163.7	164	-0.3	23.1	21.2	1.9
35-44	61.7	60.2	1.5	162.8	165.8	-3.0	23.5	21.9	1.6
45-54	64.4	60.5	3.9	161.9	163.5	-1.6	25.0	22.6	2.4
55-64	67.8	62.8	5.0	160.6	163.1	-2.5	26.6	23.7	2.9
65-74	67.8	65.0	2.8	159.5	162.9	-3.4	27.1	24.4	2.7

<sup>a</sup> HES: Health examination survey

<sup>b</sup> HIS: Health interview survey

5 kg) than among men (between 0 and 3.8 kg). Among men, the largest difference (3.8 kg) is observed between 35 and 44 years, but later among women (5 kg, between 55 and 64 years).

The height as reported in HIS is almost always greater than that observed in HES, with a difference of up to 3.5 cm for men. As for weight, the difference tends to be larger for women than for men, with no substantial trend according to age.

These discrepancies result in a mean BMI which is systematically lower in HIS than in HES. This difference is larger in women (between 1.6 and 2.9 kg/m<sup>2</sup>) than in men (between 0.3 and 2.1 kg/m<sup>2</sup>). This difference tends to increase with age among men, but it is quite stable among women. This pattern is also seen in *figure 1*.

More information is given in *figure 2*, showing the differences between HIS and HES expressed as proportions of the HIS values. In both genders and at most ages, the relative difference is larger for weight than for height. The relative difference in BMI increases with age: this is not due to a trend in weight difference (which actually decreases after the age 35-44), but in height difference (which increases with age): because height is

taken at its squared values in the BMI formula, it profoundly affects the final value of BMI.

*Table II* shows that the prevalence rates of over-weight (BMI > 25 kg/m<sup>2</sup>) are substantially different between the surveys: differences between surveys are larger for women than for men. There is a non systematic pattern of differences according to gender for obesity (BMI > 30 kg/m<sup>2</sup>). The magnitude of these differences is substantial: prevalence of obesity according to HES is threefold the prevalence from HIS for men aged 65-74. Among women, prevalence of overweight (> 25 kg/m<sup>2</sup>) is twofold from HES when compared to HIS after age 35.

## DISCUSSION

This study takes a very practical point of view in comparing the mean values and prevalence rates obtained in two surveys conducted simultaneously in the same population. Overall, this comparison shows that each survey produces different results although not totally dissimilar. Furthermore, the magnitude of these differences are specific for age group and gender.

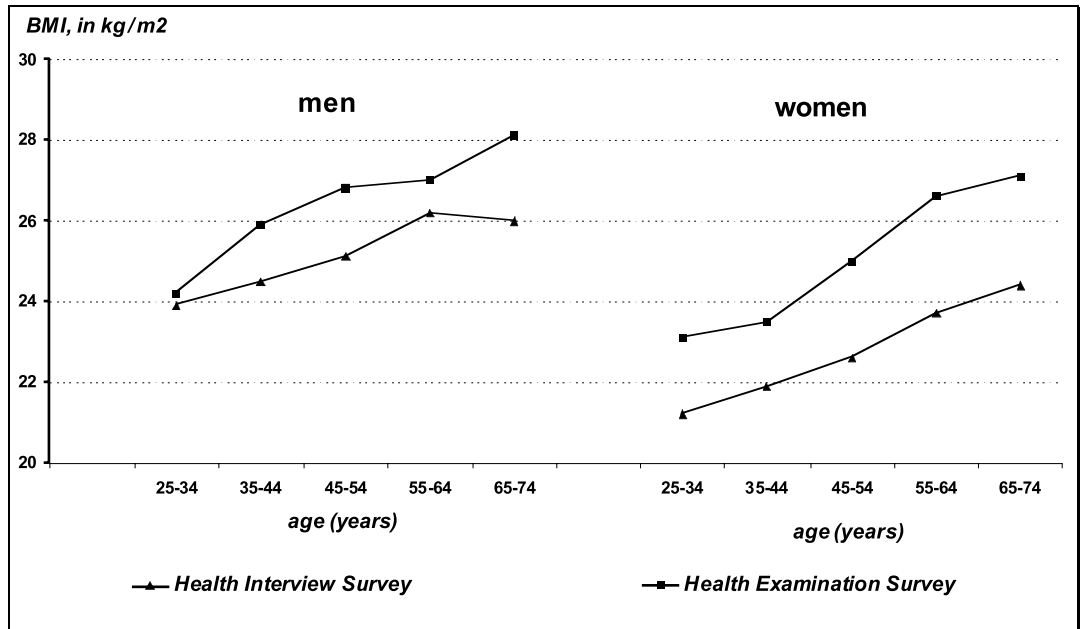


FIG. 1. — Mean values of Body Mass Index (BMI, kg/m<sup>2</sup>) according to survey, age and gender. Vaud, 1992-93.

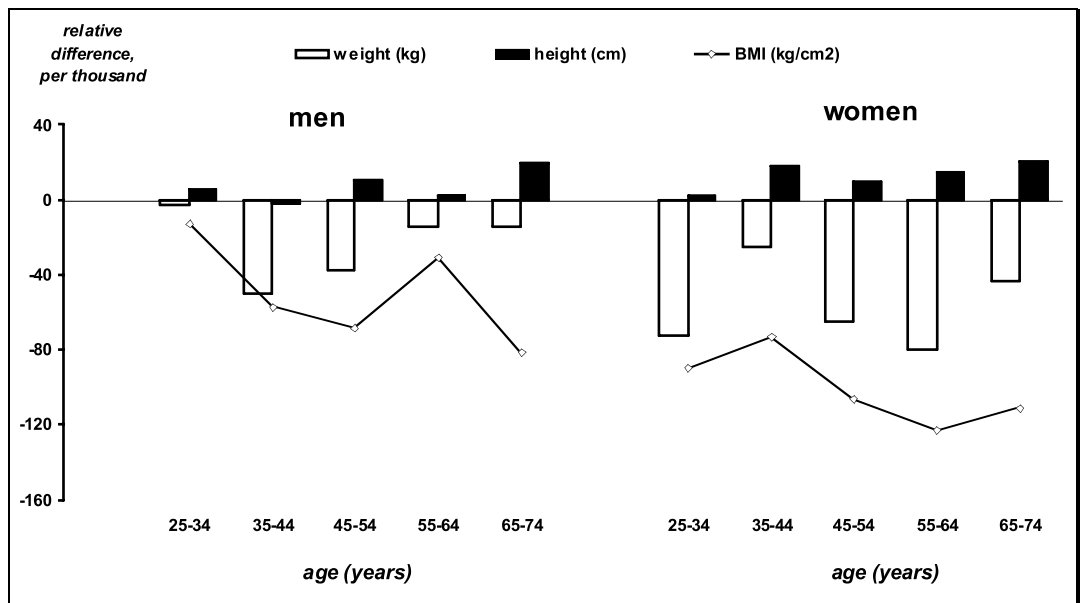


FIG. 2. — Relative differences (per thousand) of mean values of weight, height and BMI obtained from HIS in comparison with those obtained from HES, by gender and age. Vaud, 1992-93..

The most substantial limitation of this study is that the two surveys are not based on the same frame population (i.e., the set of persons for whom an enumeration is made prior to the selection): unlike HES, the HIS design excluded persons living in institutions and those not speaking one of the three main Swiss languages. Thus, part of the differences might be related to a structural difference in the frame population. However, it is unlikely that the pattern of differences observed in these two surveys is related to the difference in design.

The (unplanned) simultaneity of these surveys offers a unique opportunity to explore the differences of estimates produced by two types of surveys, i.e. an health examination survey and a telephone survey. Most validation studies of telephone surveys analyze the relationship between measured and reported biological values for the same individuals: however, these studies ignore the fact that observed values also depend on biases related to the participation (i.e., to the difference of values between participants and non participants) and to non response to the item (i.e., to the differences of values between the responders and non responders to the specific question under scrutiny [7, 8]). Since these biases are likely to be different between examination and telephone surveys, the direction and the size of the differences cannot be inferred directly from validation studies conducted at the individual level.

In this study, mean values of weight and height are systematically different between the two surveys at all ages and in both genders (*tables I and II*). As a result, mean BMI is lower in HIS than in HES, by 1-2 kg/m<sup>2</sup> among men and by 2-3 kg/m<sup>2</sup> among women. Moreover, the prevalence rates of overweight and obesity according to HIS are grossly lower than those according to HES, often by two or three times. It is unlikely that this discrepancy is due to a selection effect, i.e., that HES selects heavier participants than HIS: on the contrary, there is some evidence that obese persons are less likely to participate in examination surveys [9]. The main source of error here is probably an information bias, i.e., the underestimation of weight and the overestimation of height in HIS [10]. Men may report their weight and height as measured at the military recruitment (which is compulsory and occurs at age 19 in Switzerland): in other words, men may accurately report obsolete information, explaining that in the age range 35-54 years, HIS estimates are lower than HES (*table I*). After the age of 50 or 60, they are more likely to attend the physician and receive updated information on their weight.

For women, the larger discrepancy (stable across age groups) might be due to the fact that height and weight are more sensitive information: trying to lose weight and dieting is more common among women than among men [11, 12], conducting some to cheat the interviewer (and/or herself). Moreover, since weight tends to vary over

TABLE II. — Prevalence (%) of overweight and obesity according to survey, age and gender. Vaud, 1992-93.

Age	Men						Women					
	BMI>25kg/m <sup>2</sup>			BMI>30kg/m <sup>2</sup>			BMI>25kg/m <sup>2</sup>			BMI>30kg/m <sup>2</sup>		
	HIS <sup>a</sup>	HES <sup>b</sup>	Diff	HIS <sup>a</sup>	HES <sup>b</sup>	Diff	HIS <sup>a</sup>	HES <sup>b</sup>	Diff	HIS <sup>a</sup>	HES <sup>b</sup>	Diff
25-34	33.0	34.5	-1.5	3.7	6.3	-2.6	11.2	22.4	-11.2	2.4	7.1	-4.7
35-44	41.1	54.9	-13.8	4.4	12.2	-7.8	13.8	29.0	-15.2	3.2	5.9	-2.7
45-54	49.2	64.6	-15.4	9.5	20.4	-10.9	18.8	44.0	-25.2	3.5	9.4	-5.9
55-64	62.7	73.4	-10.7	11.8	18.3	-6.5	28.8	59.2	-30.4	8.2	19.4	-11.2
65-74	52.7	79.4	-26.7	10.9	30.9	-20.0	36.2	65.5	-29.3	12.1	16.7	-4.6

<sup>a</sup> HES: Health examination survey

<sup>b</sup> HIS: Health interview survey

TABLE III. — Prevalence (%) of overweight according to two US survey, by age and gender. BRFSS, 1990 [20] and NHANES, 1988-91 [21].

Age	Men (BMI>27.8 kg/m <sup>2</sup> )			Women (BMI>27.3 kg/m <sup>2</sup> )		
	BRFSS <sup>a</sup>	NHANES <sup>b</sup>	Diff	BRFSS <sup>a</sup>	NHANES <sup>b</sup>	Diff
20-29	14.0	20.2	- 6.2	10.6	20.2	- 9.6
30-39	23.8	27.4	- 3.6	17.4	34.3	- 16.9
40-49	30.8	37.0	- 6.2	26.6	37.6	- 11.0
50-59	31.0	42.1	- 11.1	32.2	52.0	- 19.8
60-74	27.2	40.9	- 13.7	28.3	41.3	- 13.0

<sup>a</sup> Telephone survey

<sup>b</sup> Examination survey

months, respondents might choose the lowest value during the last months.

Literature constantly suggests that telephone surveys suffer from a systematic bias in reporting weight and height. Wing *et al.* [13] reported that young women understated their weight more than men, although Charney *et al.* [14] did not find any gender differential. Pirie *et al.* [15] also found an underestimation among adults aged 20-59 years, larger among females than among males (light men even tend to exaggerate their weight). One validation study [16] showed that height was overestimated both by men (2.3 cm) and by women (0.9 cm); in both gender, overestimation increased with age. Another study showed similar differences in weight (2.2 kg) and in height (2 cm) in both gender [10]. For weight, the men underreported real values by 1.5 kg (on average), with an increase in underreporting with weight; as in the present study, the difference was larger among middle aged men. Among women the underreporting of weight was larger with a difference of 2.4 kg on average, with a decrease with age and an increase with actual weight. According to comparison studies made at the individual level [17, 18], self-reported obesity has been found to have a sensitivity of 74% and a specificity of 99% [10] when compared with direct measurement. A study in an occupational setting in France [19] found a sensitivity of 82% for men and 80% for women, and sensitivity of 98% and 99%, respectively.

The results from two published surveys from United States [20, 21] are presented in *table III*.

Although the age groups and the cut off points for overweight are not exactly comparable with the present study, this suggests a similar pattern of differences in the US surveys, i.e., the telephone survey (BRFSS) provides lower estimates of prevalence of overweight than examination survey (NHANES). Furthermore, the pattern of difference between the surveys according to gender and age is similar with the one observed in Switzerland, i.e., the difference tends to be larger for female and tends to increase with age.

Thus, although BMI is a good candidate for telephone surveys because most respondents are able to give their weight and height in numbers [22], the reporting is strongly biased. This bias always acts in the same direction, but its magnitude changes across age and gender.

Correction methods have been suggested [23], using the mean of several answers to the same question (instead of a single value) to increase the reliability of self-reported values [10]. However, the assumption underlying such an approach is that low validity is exclusively related to poor reliability. Furthermore, this approach requires the repetition of the same survey, which clearly increases the costs for only marginal improvement [10, 23]. Other methods require sophisticated methods of data collection, e.g. the Randomized Response Interview [24, 25]. Other strategies aimed at increasing the validity of self-reported biological measure should address the best possible design of the question and the development of aids to recall [8]. One way to check the validity of self-reported values would be to ask participants to

mention the time of the last measure, or the ideal value they would consider for themselves.

## CONCLUSIONS

For practical reasons and cost considerations, monitoring of risk factors is likely to rely increasingly on telephone surveys [20, 26-28]. Despite its limitation, this study shows that substantial problems do exist with this method of data gathering. Thus, improving the related methods of self-reported values is of crucial importance. In fact an effort similar to the one made for standardizing the measurement tools and processes in health examination surveys should be made in telephone surveys.

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