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Assessment of the availability and quality of Swiss data required to conduct a full CBA in the field of obesity prevention

Part II of the project “Exploratory study on obesity: Economic evaluation on health promotion and prevention”

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Abstract

As soon as the effectiveness of prevention measures in Switzerland is measured in terms of number of overweight or obese cases avoided, the prevention measures could also be evaluated economically. However, the quality of such an analysis essentially hinges on the number of comorbidities considered and on the accuracy of both the relative risk factors and the employed cost of illness estimates.

Sobald die Wirksamkeit von Präventionsmassnahmen in der Schweiz anhand der verringerten Anzahl Fälle von Übergewicht und Adipositas gemessen wird, können die Präventionsmassnahmen auch ökonomisch evaluiert werden. Die Qualität einer solchen Analyse hängt jedoch im Wesentlichen von der berücksichtigten Anzahl von Komorbiditäten wie auch von der Genauigkeit der relativen Risikofaktoren und der Schätzungen aus Krankheitskostenstudien ab.

Dès que l'efficacité des mesures de prévention en Suisse sera évaluée en termes de nombre de cas d'individus en surpoids et obèses évités, les mesures de prévention pourront aussi être évaluées économiquement. Cependant, la qualité d'une telle analyse repose essentiellement sur le nombre de comorbidités pris en compte, sur l'exactitude des facteurs de risques relatifs et sur les estimations du coût de la maladie utilisées.

Key Words

Obesity, overweight, prevention, cost-benefit analysis, Switzerland, cost of illness

Obésité, surpoids, prévention, analyse coûts-bénéfices, Suisse, coûts de maladie

Adipositas, Übergewicht, Prävention, Kosten-Nutzen-Analyse, Schweiz, Krankheitskosten

Contents

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The mandate

In the light of the growing obesity epidemic, Switzerland is currently developing a strategy for encouraging healthy lifestyles and a healthy balance of nutrition and exercise. As part of its planning, the Swiss Federal Office of Public Health (FOPH) called upon the WIG to provide it with research evidence in this domain. Relevant knowledge can be provided from two sources: (1) in order to evaluate the Federal Office's strategy and interventions one needs to know what research exists worldwide on key environmental factors which lead to obesity and overweight in order to decide what data is needed for future strategic evaluation in Switzerland, but also (2) to know the data availability and quality in Switzerland in order to conduct economic evaluations of prevention measures. Together, these two parts are intended to help the FOPH's intervention policy and evaluation strategy of obesity and overweight. This report is intended to fulfil part two of these needs – namely to discuss the requirements for a cost-benefit analysis (CBA) of prevention interventions in the field of overweight and obesity and to assess how far they are met at this point. The report on existing research, Part one, is available together with this report on the FOPH website http://www.bag.admin.ch/evaluation/01759/07612/07620/

List of abbreviations

BASPO	*Federal Office of Sport (Bundesamt für Sport)*
BMI	*Body mass index*
CBA	*Cost-benefit analysis*
COI	*Cost-of-illness*
ETEC	*Federal Departement of the Environment, Transport, Energy and Communications (Eidgenössisches Departement für Umwelt, Verkehr, Energie und Kommunikation)*
ETHZ	*Swiss Federal Institute of Technology Zurich*
EVE	*Einkommens- und Verbrauchserhebung*
FOPH	*Swiss Federal Office of Public Health (Bundesamt für Gesundheit)*
FSO	*Swiss Federal Statistical Office (Bundesamt für Statistik)*
HABE	*Haushaltsbudgeterhebung*
HPS	*Health Promotion Switzerland (Gesundheitsförderung Schweiz)*
ICH Unisi	*Institute of Communication and Health at the University of Italian Switzerland*
ISPM	*Institute of Social and Preventive Medicine*
MOSEB	*Monitoring System of Nutrition and Physical Activity (Monitoring-System Ernährung und Bewegung)*
OR	*Odds ratio*
PAF	*Population attributable fraction*
RR	*Relative risk*
SHP	*Swiss Household Panel*
SHS	*Swiss Health Survey (Schweizerische Gesundheitsbefragung)*
SIPA	*Swiss Institute for the Prevention of Alcohol and Drug Problems (Schweizerische Fachstelle für Alkohol- und andere Drogenprobleme)*
WHO	*World Health Organization*
ZHAW	*Zurich University of Applied Sciences Winterthur (Zürcher Hochschule für angewandte Wissenschaften Winterthur)*

Glossary

body mass index	*Measure to assess fatness of the human body, calculated as weight in kilograms divided by height in meters squared.*
comorbidity	*Literally "additional disorder/disease"; in this report the term indicates a medical condition in a patient that is caused by a risk factor (i.e. being overweight or obese) in the same patient.*
cost-of-illness study	*Assessment of the economic burden of a health problem.*
direct costs	*Costs associated with self-care, informal care, medical diagnosis and treatment, continuing care and rehabilitation.*
external validity	*Degree to which the results of a study can be generalized to individuals outside the study population.*
indirect costs	*This term has been used in the past to denote the production losses as a consequence of a disease. Since this term can cause confusion with the term used in the accountancy profession to denote overhead costs, we do not use this term in this report.*
intangible costs	*Value of health per se and quality of life lost due to a disease.*
internal validity	*Degree to which the results of a study are true for the group of subjects who participated in the study.*
odds ratio	*The ratio of the odds of an event in one group to the odds of an event in another group. An odds ratio of one indicates no difference between comparison groups. When the risk is small, odds ratios are very similar to risk ratios.*
panel (data)	*Longitudinal statistical study in which a group of individuals is interviewed on the very same questions at different points of time.*
population	*The group of people being studied, usually by taking samples from that population. Populations may be defined by any characteristics e.g. geography, age group, certain diseases.*
population attributable fraction	*The proportion of disease burden causally explained by a risk factor*

prevalence	*Proportion of a population having a particular condition or characteristic at one point of time*
proxy interview	*Interview where a third person answers the questions for the actual target object.*
relative risk	*Also known as risk ratio. It is the risk of developing a disease relative to exposure. A relative risk of three indicates a probability of developing the disease threefold higher in the exposed group than in the unexposed group, while a relative risk of one indicates no difference between comparison groups.*
sample	*Subset of the population of interest; used to draw inference on the population.*
sensitivity analysis	*Sensitivity analysis involves repetition of an analysis under different assumptions to examine the impact of these assumptions on the results.*

Index of tables

1 Introduction

Overweight and obesity have been on the rise for the past 30 years and are now considered a major challenge to public health in western societies. This also applies to Switzerland where according to the latest Swiss Health Survey (SHS) an estimated share of 28.6% of the adult population were overweight and 8.1% were obese in 2007. Especially the strong rise in the prevalence of obesity among Swiss children (Zimmermann et al. 2004a) is alarming considering the high risk of obese children becoming overweight or obese adults. (Freedman et al. 2005).

Obesity is considered a disease (Heshka and Allison 2001) and is together with overweight a major risk factor for other diseases (MacMinn et al. 2007). These conditions impose costs on society due to health care expenses, lost production opportunities and reduced wellbeing. All members of an insurance pool, i.e. all Swiss citizens, face the external costs of overweight and obesity (Bhattacharya and Sood 2007) while obese individuals themselves are more likely to be unemployed (Lundborg et al. 2006; Morris 2007), to earn lower wages (Conley and Glauber 2007) and to be less satisfied with their lives (Stutzer 2007).

Against this backdrop, the need for prevention measures seems evident. Several prevention interventions have therefore been launched by the government, parastatal institutions and private organizations during the last few years. While these efforts to halt the rise in prevalence expand, knowledge on their effectiveness and on their efficiency is still limited. The Swiss Federal Office of Public Health (FOPH) is commissioned by law to demonstrate the effectiveness, appropriateness and efficiency of interventions affecting health. This can be achieved by a cost-benefit analysis (CBA) which allows the evaluation of these activities from a societal perspective, to compare alternative measures and to decide how much money to spend on prevention measures. Thus, the aim of this report is to assess the availability and quality of Swiss data required to conduct a full cost-benefit analysis (CBA) of the prevention of overweight and obesity in the future.

This work complements two studies also commissioned by the Swiss Federal Office of Public Health (FOPH). In the first study, Stamm et al. (2008b) assess the availability and quality of Swiss data with a specific focus on nutrition and physical activity (i.e. some of the determinants of overweight and obesity) within the framework of a monitoring system of nutrition and physical activity (MOSEB). In comparison, our assessment focuses on the health outcome, i.e. the prevalence and the costs of obesity and its comorbidities. The second study by Schneider et al. (2009) is an update of their own cost-of-illness (COI) study from 2004 (Schneider and Schmid 2004). The authors estimated the burden of obesity based on the currently available cost data. A COI study is needed as an input for a CBA of a health care intervention so that the benefit of the intervention can thereby be calculated. Therefore it is particularly interesting to assess the work by Schneider et al. (2009) and its sources as this information may be part of the foundation of a future CBA of prevention and health promotion interventions in the field of obesity.

This report will expose the requirements for a CBA briefly in section 2. In section 3 different measures to assess the prevalence of overweight and obesity are compared and the availability and quality of prevalence data in Switzerland is discussed. Sections 4 and 5 address the availability of relative risk factors and cost data of weight related diseases (i.e. comorbidities) needed to calculate the costs of overweight or obesity as risk factors. We then discuss the available data on the costs and on the effectiveness of prevention interventions in section 6. Finally, in section 7, we draw conclusions and give recommendations to make a CBA of prevention measures against overweight and obesity possible in the future.

2 Data requirements for cost-benefit analysis in the field of prevention of overweight and obesity

In a cost-benefit analysis (CBA) of prevention measures the costs of interventions are compared to the monetary valuation of the total societal costs saved by the prevention of negative health outcomes. In general such an analysis is based on three main components: The costs of an intervention, the improvement of the health state thanks to the intervention, and the monetary value of the improvement. While the first can be obtained from the financial records of the responsible institutions, the effectiveness and the benefit of the steps taken are more difficult to prove. The benefit of prevention interventions corresponds to the avoided societal costs comprising health care costs, lost production and individual suffering.

It's a feature of overweight and obesity that the main costs they impose on society are caused by weight related health problems. Therefore a CBA has to account for the costs saved due to a decrease in these comorbidities of overweight and obesity as well.

Total costs of overweight and obesity can be calculated as follows: The costs of obesity not related to any other disease have to be added to the weight related costs of the comorbidities. The weight related costs are derived by the multiplication of the total societal costs of a comorbidity by the population attributable fraction (PAF), i.e. the share of the disease that is attributable to overweight or obesity. This PAF is derived from relative risk (RR) factors taken from the medical literature and the prevalence of overweight or obesity in the population of interest. The resulting total societal costs per overweight or obese individual can then be used to value the cases that are avoided by prevention interventions.

A CBA according to this process requires the following information:

- Prevalence of overweight and obesity in Switzerland
- Relative risk factors for comorbidities of overweight and obesity
- Total societal costs caused by the comorbidities of overweight and obesity
- Effectiveness of prevention interventions in terms of cases avoided
- Costs of prevention interventions

We structure our report accordingly.

3 Prevalence of overweight and obesity

Prevalence of overweight and obesity can be assessed by several measures. We introduce these measures and discuss their validity.

3.1 Measures to assess overweight and obesity

3.1.1 Body mass index

Body mass index (BMI) is by far the most prominent indicator used in the social science literature to assess overweight and obesity. The reason is straightforward as the two components of the ratio are easily measurable and usually memorized by the population.

The BMI has maintained its position although it has come under criticism in the medical literature for several years blaming it to be an imprecise measure of fatness because it does not distinguish fat from muscle, bone, and other lean body mass. As a result, BMI overestimates fatness foremost among those who are muscular (Prentice and Jebb 2001; Burkhauser and Cawley 2008). As the most common definition of overweight and obesity is based on the BMI (in the Western world: overweight = BMI ≥ 25 and < 30; obesity = BMI ≥ 30), this classification suffers the same limitation as the BMI.

For children the classification is different: Instead of set thresholds, BMI values are compared to typical values of other children of the same age. Before Cole et al. (2000) established a standard definition derived from an international comparison, most countries used to apply their own values stemming only from national studies (see for example Zimmermann et al. (2000)). Nowadays most studies refer to either the values published by Cole et al. (2000) or Ogden et al. (2002). Zimmermann et al. (2004b) compared both values with data from Swiss children to identify the reference data more suitable for Switzerland. The cut-off values defined by Ogden et al. (2002) performed better.

The validity of the BMI is further limited by the common practice in social science to let the respondents self-report their height and weight. It is widely agreed that the prevalence of overweight and obesity is underestimated on the basis of self-reported BMI due to misreporting behaviour of the participants (Roberts 1995; Niederhammer et al. 2000; Roussow et al. 2001; Spencer et al. 2002; Connor Gorber et al. 2007; McAdams et al. 2007). For the case of Switzerland this was shown by Faeh et al. (2008).

A systematic review on the bias of self-reported height and weight by Connor Gorber et al. (2007) gives a comprehensive survey of the different strands of literature in the field.[1] The vast majority of the reviewed articles find downward biased indicators of

[1] A women specific literature review is provided by Engstrom et al. (2003).

body mass based on self-reported data. This observation is generally explained by an overestimation of height and an underestimation of weight by surveyed individuals.[2] The mean deviation of self-reported height and weight from their measured values ranges from +0 cm to +7.5 cm and +0.6 to -3.5 kg respectively among the cited studies.[3] The average difference between self-reported and measured BMI varies between -0.2 and -1.8 kg/m^2 with a median difference of -0.8 kg/m^2. In addition to this systematic bias some papers address the greater variance of self-reported indicators to be taken into account when conducting empirical analyses or when correcting self-reported BMI (Rowland 1990; Klipstein-Grobusch et al. 1998; Villanueva 2001; Elgar et al. 2005). Researchers trying to determine the prevalence of overweight and obesity in a population need to be aware of the fact that the misclassified share of participants depends on the distribution of BMI around cut-off values as well as on the accuracy of the body mass indicator itself.

Consequences of biased body mass information for cost-benefit analyses

Biased indicators of body mass not only give a false impression of the prevalence of overweight and obesity but can also lead to miscalculated relative risk (RR) factors for weight related diseases. If the prevalence of a comorbidity is measured correctly, while the prevalence of obesity is underestimated among the diseased, the RR of contracting a weight related illness may be underestimated.[4] A case-control study conducted among Mexican adults revealed an association between obesity and asthma in men that had not been detected earlier due to the use of underestimated body mass indices (Santillan and Camargo 2003). Contrariwise moderately obese subjects possibly sort themselves into the class of overweight people when under-reporting their BMI whereas severely obese individuals stay denominated as obese despite misreporting. This may lead to a situation where only severely obese individuals with a high prevalence of comorbidities are identified as such, and therefore the RR can be overestimated (Chiolero et al. 2007). Overestimated RR lead to overestimated costs of overweight and obesity and therefore a CBA shows too high benefits of prevention interventions. Hence, it is crucial to use measured indicators of overweight and obesity to quantify the relative risks for comorbidities of these conditions. If this is not feasible at least correction procedures for self-reported body mass indices need to be conducted.

Correction of self-reported body mass indices

If measured and self-reported height and weight information is available at the same time for at least a portion of a sample, a regression can be conducted to calculate the

[2] A short review on the individual determinants (i.e. gender, age, socioeconomic and overweight status) of the bias in self-reported BMI is given in Appendix I.

[3] However, the review also contains several papers concerning special populations like people with eating disorders.

[4] For more details on relative risks, see section 5.

estimated bias between the self-reported and the "true" body mass. Since there may be systematic differences in the misreporting behaviour between different groups of people, individual characteristics help to improve this analysis. The results of such a regression can be used to estimate a correction factor or a "true" value for every individual in the dataset. If no measured information is available for the group of interest, coefficients could be taken from other studies in a comparable setting. Connor Gorber et al. (2008) conducted a regression in a Canadian sample explaining the true BMI by self-reported BMI and other individual factors.[5] Their estimated coefficients can be used to predict "true" values of BMI if the same characteristics are available in other surveys. For the case of scarce individual information the authors even offer a simple equation that derives the actual value of body mass only from the self-reported BMI. A similar equation explaining reported BMI by the measured value was already estimated earlier by Kuskowa-Wolk and Rössner (1989) and Giacchi et al. (1998). The difference in the coefficients between the mentioned studies shows clearly how important it is to calculate the prediction parameters from a cohort similar enough to the population of interest.

3.1.2 More accurate measures of fatness

As the BMI does not validly indicate how much fat the body possesses, measurement of total body fat may be the better predictor for comorbidities. This is especially relevant for Type II Diabetes and cardiovascular disease because fat secretes hormones which cause these diseases. But if there is enough fat-free mass in the body, it might be that this can attenuate the impact of these secretions. Thus percent body fat, which is total body fat divided by total weight, would be the better indicator (Burkhauser and Cawley 2008).

In recent years, however, widespread belief in the medical literature has prevailed that it is not the amount or percentage of fat but the location and distribution of fat that best predict comorbidities, especially cardiovascular diseases (Canoy et al. 2007): Abdominal visceral fat (i.e. located around the internal organs) is associated with an elevated risk of morbidity and mortality. These fat portions can best be measured using a special kind of X-ray, but measuring it using waist circumference or waist-to-hip ratio yields just as good results if conducted properly (Snijder et al. 2002). Shen et al. (2006) showed the superiority of waist circumference compared to percent body fat. While others also appraise waist circumference as the best predictor (Janssen et al. 2004; Stolk et al. 2005; Menke et al. 2007; Simpson et al. 2007), some favour waist-to-hip ratio (Yusuf et al. 2005; Canoy 2008). In a Swiss study Marques-Vidal et al. (2008) found prevalence of abdominal obesity measured with waist circumference to be higher than BMI-derived obesity.

The major drawback of these measures is their inferior measurability. Examiners need to be well educated about which part of the body should be measured and the

[5] The mentioned correction equations are enclosed to this paper in the appendix.

equipment is more expensive whereas it takes no expert or costly tools to measure height and weight. A recent Swiss study showed that primary care physicians had poor knowledge of how the measurement of the more accurate measures should be performed (Sebo et al. 2008). Volunteers were misclassified as overweight or obese based on waist circumference and waist-to-hip ratio even after one-hour training in these measurement methods. The authors conclude that BMI is still the most reliable measure to detect obesity.

3.1.3 Conclusion

The BMI as an indirect measure of overweight and obesity might suffer from some serious limitations. There exist some more accurate measures to predict the development of comorbidities. However, the medical literature differs about which measure is the best predictor. More research on this topic is needed as well as education on how to use alternative the measurement methods. Another reason for continuing to collect the BMI in Switzerland is the future comparability of Swiss data with that of other countries, since BMI is still the most widespread measure in the social research community. We therefore recommend maintaining the use of BMI but also monitoring the trend in the literature on other methods for measuring overweight and obesity.

3.2 Availability of Swiss data on the prevalence of overweight and obesity

We screened the Swiss literature for surveys not only collecting data on the extent of overweight and obesity (measured with different methods) but also information on its determinants (i.e. the nutritional behaviour and physical activity). The basis for this search was an unpublished table prepared by the FOPH's monitoring system of nutrition and physical activity (MOSEB). The table gives an overview of the existing surveys collecting the relevant information. We adapted the table to the needs of this report and searched the corresponding literature and its references for additional information relevant for this report.

Table 1 shows a selection of surveys conducted in the past years which detect the prevalence of overweight and obesity for (part of) the Swiss population. The information given in the table includes

- the name of the survey
- the year(s) in which the survey was conducted
- whether weight and height was measured or self-reported by the respondent
- whether questions on nutritional behaviour were asked
- whether questions on physical activity were asked
- whether percent body fat was measured

- whether waist-to-hip ratio was measured
- whether waist circumference was measured
- the age of the surveyed population
- the sample size (including sex ratio if stated)
- the response rate
- the spatial coverage (i.e. geographical region)
- the responsible institution for the survey
- where the information is published.

Some features are missing as they are not provided by some surveys.

Table 1 Overview of existing Swiss surveys detecting prevalence of overweight and obesity

survey	year	weight/height		nutrition	exercise/ physical activity	%BF[a]	w/h[b]	WC[c]	age	sample size (male/female)	response rate	spatial coverage	responsible institution	published by
		self-reported	measured	self-reported	self-reported									
Swiss Health Survey	1992-93	x		x	x				>14	15288 (7930/7358)	71%	Switzerland	FSO/FOPH	Eichholzer et al. (1999)
	1997	x		x	x				>14	13004 (6254/6750)	69%	Switzerland	FSO/FOPH	Eichholzer (2002)
	2002	x		x	x				>14	19706 (8909/10797)	64%	Switzerland	FSO/FOPH	Eichholzer et al. (2005)
	2007	x		x	x				>14	18760 (8424/10336)	66%	Switzerland	FSO/FOPH	
Swiss Household Panel (first sample)	1999	x			x				>13[d]	7799[e]	85%	Switzerland	Fondation Suisse pour la recherche en sciences sociales, University of Lausanne	http://www.swisspanel.ch
	2000	x			x				>13[d]	7073[e]	84%	Switzerland		
	2001	x			x				>13[d]	6601[e]	88%	Switzerland		
	2002	x			x				>13[d]	5700[e]	89%	Switzerland		
	2003	x			x				>13[d]	5220[e]	88%	Switzerland		
	2004	x			x				>13[d]	4413[e]	85%	Switzerland		
	2005	x			x				>13[d]	3888[e]	87%	Switzerland		
	2006	x			x				>13[d]	4091[e]	81%	Switzerland		
	2007	x			x				>13[d]	4630[e]	81%	Switzerland		
Swiss Household Panel (second sample)	2004	x			x				>13[d]	3654[f]	76%	Switzerland		
	2005	x			x				>13[d]	2649[f]	75%	Switzerland		
	2006	x			x				>13[d]	2568[f]	78%	Switzerland		
	2007	x			x				>13[d]	2350[f]	80%	Switzerland		

survey	year	weight/height		nutrition	exercise/ physical activity	%BF[a]	w/h[b]	WC[c]	age	sample size (male/female)	response rate	spatial coverage	responsible institution	published by
		self-reported	measured	self-reported	self-reported									
Nutri-Trend	1985	x		x					18-50	600 (202/398)		Deutsch-schweiz / Suisse Romande	Nestlé/ FOPH	Dual-Fleckenstein and Gutzwiller (1991)
	1988	x		x					18-50	826 (277/549)		Switzerland	Nestlé/ FOPH	
	1994	x		x					18-50	827 (36%/64%)		Switzerland	Nestlé/ FOPH	Jeanmaire and Exl (1998)
	2000	x		x					18-74	1004 (478/526)		Switzerland	Nestlé/ FOPH	Exl-Preysch et al. (2005)
BusSanté	yearly since 1993		x	x	x				35-74	approx. 1000		1 canton (Geneva)	Geneva University Hospital	
	1993-94		x	x	x				35-74	1489 (773/716)		1 canton (GE)		Morabia et al. (1997)
	1993-2000		x	x	x				35-74	8194 (4207/3987)	57-65%	1 canton (GE)		Galobardes et al. (2003)
	1993-2000		x	x	x				35-74	12271 (6164/6107)	57-65%	1 canton (GE)		Morabia and Costanza (2005)
	1997-99		x	x	x				35-74	3410 (1707/1703)	62%	1 canton (GE)		Bernstein et al. (2001)
MONICA[g]	1984-85		x	x	x				25-74	1891 (968/923)	57%	2 cantons (VD FR)	WHO/ISPM Lausanne	Wietlisbach et al. (1997)
	1988-89		x	x	x				25-74	2011 (1034/977)	61%	2 cantons (VD FR)	WHO/ISPM Lausanne	Wietlisbach et al. (1997)
	1992-93		x	x	x		x	x	25-74	1742 (843/899)	53%	2 cantons (VD FR)	WHO/ISPM Lausanne	Wietlisbach et al. (1997)

survey	year	weight/height		nutrition	exercise/ physical activity	%BF[a]	w/h[b]	WC[c]	age	sample size (male/female)	response rate	spatial coverage	responsible institution	published by
		self-reported	measured	self-reported	self-reported									
MONICA TI	1992-93		x	x	x		x	x	35-64	1510 (737/773)	76%	1 canton (TI)	WHO/ISPM Lausanne	Paccaud et al. (2000)
SOMIPOPS	1980-84	x		x					>19	4255	73%	Switzerland	Kantons-spital Basel	Gutzwiller et al. (1985a)
NRP 1A	1977-78		x	x	x				>16	2206	34%	4 cities (Aarau, Solothurn, Nyon, Vevey)		Gutzwiller et al. (1985b)
CoLaus	2003-04		x	?	x			x	35-75	6188 (2937/3251)	43%	1 city (Lausanne)		Firmann et al. (2008) / Marques-Vidal et al. (2008)
Vaud	1998-2003		x					x	16-74	15864 (10465/5399)		1 canton (VD)		Darioli et al. (2004)
AIR94	1994		x		x		x		51(16 sd)	1099 (only m)		visitors of an air show		Suter et al. (1997)
Meeting Point Heart and Brain	2001		x						4-95	4458 (1741/2717)		8 shopping malls CH	Swiss Heart Foundation	Nedeltchev et al. (2005)
Geneva	1993		x		x				20-74	802 (511/291)		1 city (Geneva)		Kyle et al. (2007)
	2003		x		x				20-74	1631 (821/810)		1 city (Geneva)		Kyle et al. (2007)
EURALIM[h]	1993-96		x						29-83	2123 (1083/1040)	65%	1 canton (GE)		Beer-Borst et al. (2000)

survey	year	weight/height		nutrition	exercise/ physical activity	%BF[a]	w/h[b]	WC[c]	age	sample size (male/female)	response rate	spatial coverage	responsible institution	published by
		self-reported	measured	self-reported	self-reported									
HEUREKA	1991	x							20-80	11119 (5115/6004)		visitors of expo in Zurich		Suter et al. (1993)
Luftibus	1993-98	x[i]							>20	30598 (14173/16425)		1 canton (ZH)	Lungenliga ZH	Egger et al. (2001)
Luftibus II	2003	x		x	x				11-92	2071 (1004/1067)	32%	1 canton (ZH)	Lungenliga ZH	Egloff (2007)
ch-x	2002	x			x				+/- 20	20531		Switzerland	ISPM Zurich	www.chx.ch
Null-messung	2006	x							>15	1441		Switzerland	ICH Unisi	Schulz et al. (2007)
EVE/HABE[j]	1990			x								Switzerland	FSO	http://www.bfs.admin.ch/bfs/portal/de/index/infothek/erhebungen__quellen/blank/blank/habe/intro.html
	1998			x					>0[k]	9295	30%	Switzerland	FSO	
	2000			x					>0[k]	3642	28%	Switzerland	FSO	
	2001			x					>0[k]	3740	31%	Switzerland	FSO	
	2002			x					>0[k]	3726	30%	Switzerland	FSO	
	2003			x					>0[k]	3475	31%	Switzerland	FSO	
	2004			x					>0[k]	3240		Switzerland	FSO	
	2005-08			x					>0[k]			Switzerland	FSO	
Hepa Survey	1999				x				>14	1529	64%	Switzerland	BASPO	Martin et al. (1999)
	2001				x				>14	1535	56%	Switzerland	BASPO	Martin (2002)

survey	year	weight/height		nutrition	exercise/ physical activity	%BF[a]	w/h[b]	WC[c]	age	sample size (male/female)	response rate	spatial coverage	responsible institution	published by
		self-reported	measured	self-reported	self-reported									
Bewegungs-survey	2004				x				>14	2115		Switzerland	BASPO	www.aramis.admin.ch Projectnr. 04-011
Mikrozensus zum Verkehrs-verhalten	1974				x				>5	5514		Switzerland	ETEC	http://www.bfs.admin.ch/bfs/portal/de/index/themen/11/07/01/02.html http://www.are.admin.ch/themen/verkehr/00256/00499/00500/index.html?lang=de
	1979				x				>13	2000 (households)		Switzerland	ETEC	
	1984				x				>9	8846 (4250/4596)	60%	Switzerland	FSO/ETEC	
	1989				x				>9	43009 (21344/21515)	63%	Switzerland	FSO/ETEC	
	1994				x				>5	18020	75%	Switzerland	FSO/ETEC	
	2000				x				>5	29407 (49%/51%)	70%	Switzerland	FSO/ETEC	
	2005				x				>5	33390	65%	Switzerland	FSO/ETEC	

Childern & adolescents

ETHZ	1999		x						6-12	595 (297/298)		Switzerland	ETHZ	Zimmer-mann et al. (2000)
	2002		x			x (SFT)[l]			6-12	2431 (1196/1235)	76%	Switzerland	ETHZ	Zimmer-mann et al. (2004a)
	2007		x			x (SFT)[l]			6-14	2303 (1128/1175)	73%	Switzerland	ETHZ	Aeberli (2008)

survey	year	weight/height		nutrition	exercise/ physical activity	%BF[a]	w/h[b]	WC[c]	age	sample size (male/female)	response rate	spatial coverage	responsible institution	published by
		self-reported	measured	self-reported	self-reported									
HBSC	1986			x						1661		Switzerland	SIPA	Schmid et al. (2008)
	1990	x		x						2523		Switzerland	SIPA	Schmid et al. (2008)
	1994	x		x	x				11-15	8698		Switzerland	SIPA	King et al. (1996)
	1998			x	x				11-15	5520 (2744/2776)		Switzerland	SIPA	Currie et al. (2000)
	2002	x		x	x				11-15	4679 (2309/2370)		Switzerland	SIPA	Currie et al. (2004)
	2006	x		x	x				11-15	9791 (4899/4892)	86%	Switzerland	SIPA	Kuendig et al. (2007)
SMASH	1992-93			1)	x				15-20	9268 (5275/3993)	92-98%	Switzerland	ISPM Lausanne	Ferron et al. (1997) / Renaud et al. (2001) / Narring et al. (1994)
1)	1992-93			x					15-20	1318 (751/567)	100%	German part of CH	Nestlé	Narring et al. (1997)
SMASH	2002	x		x	x				16-20	7428 (3384/4044)	100%	Switzerland	ISPM Lausanne	Narring et al. (2004)
1st Zurich Longitudinal	1960-65		x			x			6-12	232 (120/112)		area of Zurich		Gasser et al. (1993)
2nd Zurich Longitudinal	1980-90					x			6-12	190 (101/89)		area of Zurich		Largo et al. (1989)
Cohort Laus	1985-96		x						5-16	1203 (608/595)		1 city (Lausanne)	city of Lausanne	Woringer and Schütz (2003)

survey	year	weight/height		nutrition	exercise/ physical activity	%BF[a]	w/h[b]	WC[c]	age	sample size (male/female)	response rate	spatial coverage	responsible institution	published by
		self-reported	measured	self-reported	self-reported									
BMI-Monitoring	2005-06		x						4-16	10682 (5496/5186)		3 cities (BS/BE/ZH)	Schulärztliche Dienste	Stamm et al. (2007)
	2006-07		x						4-16	11742 (5967/5775)		3 cities (BS/BE/ZH)	Schulärztliche Dienste	Stamm et al. (2008a)
	2007-08		x						4-16	12779 (6430/6349)		3 cities (BS/BE/ZH)	Schulärztliche Dienste	Stamm et al. (2009)
Scarpol	2005	x			x				6-7/ 9-10/ 13-14	1345 (proxy interviews with parents)	65%	3 cities (Bern, Biel, Payerne)	ISPM Basel	Bringolf-Isler et al. (2008)
Buddeberg	1993		x	x					14-19	1944 (829/1115)	99%	1 canton (ZH)	University hospital Zurich	Buddeberg-Fischer (2000)
Zürichsee	1999		x	*	*	x (SFT)[l]			(1-3 grade) /6-10	872 (462/410)	95%	4 municipalities of canton ZH		Stettler et al. (2004)
Waadt	1996		x	x	x				9-19	3540 (1778/1762)	96%	1 canton (VD)	ISPM Lausanne / Nestlé	Narring et al. (1998) / Cavadini et al. (2000) / Decarli et al. (2005)
St. Gallen	1991-92			x					7-16	481 (241/240)		1 city (St. Gallen)		Baerlocher and Laimbacher (2005)
	1998-99	x		x					7-12	557 (285/272)		1 city (St. Gallen)		

survey	year	weight/height		nutrition	exercise/ physical activity	%BF[a]	w/h[b]	WC[c]	age	sample size (male/female)	response rate	spatial coverage	responsible institution	published by
		self-reported	measured	self-reported	self-reported									
Zug Kinder-garden	2000		x	x	x				5-6	340 (165/175)	73%	2 munici-palities of canton ZG	University Zurich	Steiner (2003)
Rüti	1999		x	x	x	x (SFT)[l]	x		6-14	657 (343/314)	90%	1 city (Rüti ZH)	University Zurich	Karzig (2004)
Graubünden	2001		x	x	x	x (SFT)[l]			7-13	462 (223/239)	82%	1 canton (GR)	University Zurich	Guyan (2003)
Ticino I	2000-01		x	x	x		x	x	7-13	4547 (2370/2177)	89%	1 canton (TI)	University Zurich	Bettoni (2002)
Ticino II	2003		x	x	x	x	x	x	6-17	1177 (609/568)	99%	2 munici-palities of canton TI	University Zurich	Laureti (2005)
Cantonal school Wohlen	2004		x	x	x	x	x	x	15-22	409 (179/230)	94%	1 county of canton AG	University Zurich	Thaler (2005)
Cantonal school St. Gallen	2002		x	x	x	x	x	x	16-22	551 (270/281)	91%	1 city (St. Gallen)	University Zurich	Bärlocher (2005)
Elderly														
SHARE	2004	x			x				mostly >50	1004 (462/542)	39%			http://www.share-project.org/
	2006	x			x				mostly >50	1462 (645/817)				
SENECA I	1988/89		x	x	x		x		70-76	361 (177/184)	47%	3 cities (Bellinzona, Burgdorf, Yverdon)	European Union / EURONUT	Schlettwein-Gsell et al. (1991)

survey	year	weight/height		nutrition	exercise/ physical activity	%BF[a]	w/h[b]	WC[c]	age	sample size (male/female)	response rate	spatial coverage	responsible institution	published by
		self-reported	measured	self-reported	self-reported									
SENECA II	1993		x	x	x		x		74-79	131 (62/69)		1 city (Yverdon)	European Union / EURONUT	Schlettwein-Gsell et al. (1998)
SENECA III	1999	x		x	x				80-86	242 (117/125)		3 cities (Bellinzona, Burgdorf, Yverdon)	European Union / EURONUT	Schlettwein-Gsell et al. (2005)

[a] %BF = percent body fat

[b] w/h = waist-to-hip ratio

[c] WC = waist circumference

[d] proxy interviews with those aged < 14

[e] 2209 have taken part in each of the 9 waves

[f] 1601 have taken part in each of the 4 waves

[g] only BMI > 30

[h] linked to BusSanté

[I] height was measured

[j] spendings on nutrition, not consumption

[k] those aged < 15 were not personally asked

[l] SFT = skinfold thickness

3.3 Quality of Swiss data on the prevalence of overweight and obesity

We assess the quality of the available Swiss prevalence data according to their external and internal validity.

External validity

External validity is the degree to which the results of a study can be generalized to individuals outside the study population. The degree of external validity can be adequately assessed by examining whether the distribution of the key socio-demographic and epidemiological indicators in the sample correspond to their distribution in the target population, i.e. that the distribution analysis finds no systematic difference between the sample and the population and is therefore representative. We will assess the external validity of the prevalence data of overweight and obesity based on the following four criteria, which should be published in every survey design:

Sample size: Usually the higher the sample size, the higher the probability the observed prevalence corresponds to the actual prevalence in the population (Wooldridge 2003:742).

Spatial coverage: The broader the spatial coverage, the better the observed prevalence corresponds to the actual prevalence in the population. If only a city or a canton is considered, the findings might not be applicable to the whole population, since there might be a difference between metropolitan and rural areas and between language regions.

Age: The prevalence might differ substantially between age groups. Therefore, it is important that all age groups are considered.

Response rate: If the response rate is low, a substantial part of the population did not partake in the survey. If a part of the population with either a high or a low prevalence of overweight and obesity consequently refrain from taking part in surveys, the resulting prevalence is seriously biased.

Another criterion is the sex ratio. It needs to be in line with the one of the general population. The external validity with respect to this ratio is given in almost every survey. For that reason we only point it out if it the ratio is not adequate.

Internal validity

Internal validity is defined as “the degree to which the results of a study are true for the group of subjects who participated in the study” (Luce and Elixhauser 1990:86). Or in other words: Does the indicator measure what is intended to be measured? In section 3.1.1 we showed the prevalence of overweight and obesity is underestimated when height and weight are self-reported. Thus, we indicate for each survey whether height and weight were self-reported or measured and if other measures of fatness were collected.

We assessed the external and internal validity of only the most important surveys by evaluating them on the basis of these criteria.

Unfortunately, no survey covers all age groups as children are always separated from adults. So each survey does not satisfy at least one of our quality criteria. We therefore abstain from mentioning this deficiency each time. We first assess surveys covering adults followed by those covering children.

Adult surveys

Swiss Health Survey (SHS): The SHS is by far the largest repeatedly conducted survey. It provides information on the health status of the Swiss population as well as its determinants and health care utilisation. The main part is conducted by telephone and then supplemented by a written part. For the last four surveys (1992, 1997, 2002, 2007) the sample size has been representative of the Swiss population with a minimum of 13'004 and a maximum of 19'706 participants. Because the whole country (i.e. every canton) is covered, the criterion of spatial coverage is fulfilled. The only drawback of the survey is that respondents self-report their height and weight. The response rate is adequate (64%-71%).

Swiss Household Panel (SHP): The principal aim of the SHP is to observe social change, in particular the dynamics of changing living conditions in the population of Switzerland. In a panel, one group of individuals is interviewed on the very same questions at different points of time, usually at intervals of a year. The SHP has been conducted yearly since 1999. In 2004, a second sample was added. In the first sample nearly 4'000 persons take part per year, but of these, only 2'209 persons have taken part every year. In the second sample, participation per year has dropped to 2'350 persons in the latest wave of which 1'601 persons have taken part every year. Persons from all over the country are included. The age range is not limited while children below the age of 14 are covered via proxy interviews.[6] The response rate is high (75%-89%). Unfortunately, height and weight are only self-reported.

Nutri-Trend: Nutri-Trend is a telephone survey aimed at assessing the diet of the Swiss population and has been conducted four times. The external validity of the Nutri-Trend project is similar to the SHS. The sample is much smaller, but the whole country[7] is covered and results have been weighted accordingly. The respondents were between 18 and 50 years old[8] and self-reported their height and weight. The response rate is not published.

BusSanté: BusSanté is a yearly survey that has been conducted since 1993 in the canton of Geneva where changes in the prevalence of risk factors are observed over time. The main benefit of this dataset is the measurement of height and weight. The

[6] Height and weight are not directly asked for them. The respondent was asked to estimate if the child has a normal weight, is too light or too heavy, considering the child's age and height.

[7] There is an exception as the first survey in 1985 covered only the German and French speaking part of Switzerland.

[8] In the latest survey in 2000 the age of the respondents was between 18 and 74 years.

sample size (approx. 1’000 yearly) is representative for the canton of Geneva, but not for Switzerland (urban area) and only people between 35 and 74 of age are covered.

MONICA: Within the framework of the international research project MONICA (‘‘Monitoring of trends and determinants in cardiovascular disease’’) health examination surveys were conducted three times (1984-85, 1988-89, 1992-93) in two cantons (Vaud and Fribourg). In the latest round another canton (Ticino) was included. Again the main advantage of this survey is the measurement of height and weight; in the latest wave waist-to-hip ratio and waist circumference was additionally measured. The sample size (between 1’500 and 2’000) is again representative for the selected cantons, but not for Switzerland.

Two other surveys are similar to BusSanté and MONICA, measuring height and weight and being representative of the adult population of a subpopulation: *CoLaus* for the city of Lausanne and the survey by Darioli et al. (2004) for the canton of Vaud.

There are only two surveys dating back more than 25 years: *SOMIPOPS* and *NRP1A*. SOMIPOPS is a predecessor and small version of the SHS sharing the same benefits and drawbacks. The focus of the National Research Program *NRP1A* was on the primary prevention of cardiovascular disease in Switzerland. The major benefit of this survey is the measurement of height and weight. Unfortunately, the response rate was rather low (34%) and the spatial coverage is restricted to four midsize cities.

We refer to Stamm et al. (2008b) for the quality assessment of surveys which have a spotlight on nutrition and physical activity but without the consideration of height or weight. Their evaluation of surveys is similar to ours but with a specific focus on nutrition and physical activity.

Children and adolescents

Looking at children surveys, only toddlers are never included in any survey. But from the age of 5 onwards (i.e. when most children enter school) the prevalence data of children is surveyed by means of three surveys which cover three consecutive age groups.

ETHZ Study: The 6-12-year-old are covered by the studies organised by the Swiss Federal Institute of Technology Zurich (ETHZ). A specific cluster sampling was used to obtain a representative national sample of Swiss children aged 6–12 years. In the first survey in 1999, 600 children were examined, which only represent approximately 1 in 1’000 children in this age group in Switzerland. But in the second study in 2002, 2’600 children were examined which represent about 1 in 250 children in this age group. Since then it is planned to conduct this survey every five years, parallel to the SHS. In 2007 the study was repeated with the same protocol. In all three surveys height and weight are measured; in the latest two, even skinfold thickness. The response rate is high; however, parents had to authorise participation. This might result in a bias, if the prevalence among the excluded children is significantly higher or lower than among the included.

HSBC: The 11-15-year-old are covered by the survey named “Health Behaviour in School-aged Children” (HBSC), which is a cross-national research project conducted in collaboration with the WHO Regional Office for Europe. The first cross-national survey was conducted in 1983/84, but Switzerland participated for the first time in the second survey in 1985/86. Since then data collection has been carried out every four years using a common research protocol. The most recent round, the sixth in the series with data from Switzerland, was conducted in 2005/06. However, height and weight have always been self-reported and only sampled four times (1990, 1994, 2002, and 2006). The sample size has been below 3’000 until 1990, since then it has always been greater than 5’000. Detailed information on the response rate and the spatial coverage was only available for the latest survey: The response rate was high (86%) and the spatial representativity is provided.

SMASH: Children starting at the age of 15 are covered by the SHS. In addition the Swiss Multicenter Adolescent Survey on Health (SMASH) focuses specifically on the 15-20-year-old. In the first survey in 1992, no information on either height or weight was collected. Yet, the second survey in 2002 satisfies almost all of our quality criteria. The only drawbacks are the self-reported height and weight, the only slight overrepresentation of females and the lack of those adolescents absent from the no more compulsory area of education.

Two studies (Woringer and Schütz 2003; Zimmermann et al. 2004a) compare their prevalence findings to those from the two Zurich Longitudinal Studies dating back to the 60s and 80s of the last century. The sample size of both longitudinal studies was small though and only the urban region of Zurich was covered.

The elderly

The elderly are already covered by several surveys (e.g. SHS, SHP, BusSanté). Yet, there are two surveys focussing primarily on this age group. Both are internationally linked and are designed as panel surveys allowing a longitudinal observation of the same persons.

SHARE: The Survey of Health, Ageing and Retirement in Europe (SHARE) is a multidisciplinary and cross-national panel database of micro data on health, socio-economic status and social and family networks. In the two rounds already conducted 1’004 and 1’462 individuals respectively aged 50 or over are covered from all over the country. Height and weight are self-reported and the response rate in the first round was low (39%).

SENECA: The objective of the “Survey in Europe on Nutrition and the Elderly: a Concerted Action” (SENECA) was to identify dietary and lifestyle factors that contribute to healthy ageing within the European population. The city of Yverdon was one of nine European cities which completed all three rounds of this longitudinal study (1988/89, 1993, and 1999), while two other Swiss cities participated in 1988/89 and in 1999. When the participants entered the study, they were between 70 and 76 years old. Ten years later several persons were missing as they had passed away. Again as in the SHARE project, the response rate was low in the first round. Height

and weight were measured in the first two rounds, while they were self-reported in the latest.

Because the other surveys in Table 1 do not satisfy several of our quality criteria, we do not discuss them in detail. Table 2 lists in short the advantages and drawbacks of the most important data sources.

Table 2 Quality assessment of Swiss data sources

study	advantages	drawbacks
Swiss Health Survey	-sizable sample size -representative for whole country	-height and weight not measured
Swiss Household Panel	-longitudinal design (same persons observed over years) -high response rate	-height and weight not measured
Nutri-Trend	-representative for whole country	-height and weight not measured
BusSanté	-height and weight measured -yearly conducted since 1993	-only representative for a subpopulation
MONICA CoLaus Vaud	-height and weight measured -additional measures of fatness	-only representative for a subpopulation
SOMIPOPS	-first representative study for Switzerland	-height and weight not measured
NRP 1A	-height and weight measured	-low response rate -only four cities covered
Childern & adolescents		
ETHZ	-representative for 6-12-year-old children -height -height, weight and percent body fat measured	
HBSC	-representative for 11-15-year-old children	-height and weight not measured
SMASH	-representative for 15/16-20-year-old adolescents -high response rate	-height and weight not measured
Zurich Longitudinal	-height, weight and percent body fat measured	-small sample size -only one city covered

3.4 Conclusion on availability and quality of Swiss data

The present surveys on the prevalence of overweight and obesity are only externally valid for certain populations or regions but not for the whole country. In every case at least one of the quality criteria is not fulfilled. Particularly noteworthy is the fact that there is no survey covering all age groups (“from the cradle to the grave”) and

children are always separated from adults. Nevertheless, as long as two surveys covering each age group satisfy the remaining quality criteria, it is still possible to incorporate them into an effectiveness analysis and into the calculation of the population attributable fraction (see section 4).

In most Swiss surveys height and weight are not measured objectively, but are self-reported, while other measures to assess fatness (percent body fat, waist-to-hip ratio and waist circumference) are seldom used. The available surveys which measure height and weight objectively do not satisfy our external validity criteria. It is obviously more costly to measure people than to ask them to report their height and weight and reach a representative sample size in the same survey. In section 3.1.1 we showed how the biased self-reported values can be corrected with a correction factor. But because there is no dataset containing both self-reported and measured information about height and weight in Switzerland, no Swiss correction equation can be estimated at this point. It is therefore strongly recommended to collect measured height and weight together with self-reported data at least in a representative subpopulation of a future survey in order to estimate an equation for the correction of self-reported body mass indices.

Most surveys date back to only the last 15 years. Since a continuous time series is needed to show the effectiveness of prevention measures, the measurement of body mass should be maintained.

Since the conclusion of Schutz and Woringer (2002:S3) that “there is a definitive lack of objective information in Switzerland on the prevalence of obesity at different ages” several years have passed. The question remains if this statement still holds. Our answer is yes, as there is no measured BMI data yet available that is representative for the whole country except in the case of children. With the ETHZ study a representative monitoring of the prevalence of overweight and obese children has been established. Besides the drawback of including only 6-12-year-old children, its setting satisfies all our other quality criteria. For adults no new survey has been established, leaving the Swiss Health Survey as next best alternative satisfying the most of our four external validity criteria but lacking objectively measured body mass. The Swiss Household Panel is also valuable for an effectiveness study because its longitudinal design allows observing the same individuals over a certain time. Both the SHS and SHP include variables on socio-economic status allowing focus on special groups (e.g. education, nationality) in effectiveness analyses. The two data sets provide distinct information and opportunities. The SHS is better suited to show trends as different people are interviewed at regular periods. The SHP on the other hand follows the same individuals over time and is therefore better suited to detect the true effects of an intervention. Panel data allow estimating the individual trajectories of BMI over time and this will be particularly relevant when assessing the impact of prevention programmes. However, as the main goal of the SHP is not assessing health, but observing social change in general, the SHP contains only limited information on health.

4 Relative risk of comorbidities of overweight and obesity

The entries E65-E68 for obesity in the WHO's 10th International Classification of Diseases (ICD-10) suggest that obesity is regarded as a disease in itself. This view is supported by several scholars (Heshka and Allison 2001). In addition, overweight and obesity are major risk factors for other diseases (MacMinn et al. 2007). Therefore an estimation of the societal costs of fatness has to take into account the costs of obesity itself as well as the costs of diseases attributed to overweight and obesity.

An established approach for estimating the costs for a comorbidity caused by overweight and obesity is to multiply the total costs for that disease by the factor by which it is attributable to overweight and obesity (Kortt et al. 1998; Anis et al. 2009). This factor is called the population attributable fraction (PAF). To determine what share of the prevalence of a disease is related to overweight and obesity, one has to compare the risk of overweight and obese people developing a disease with the risk of other individuals. As the equation below shows, this relative risk (RR) is generally defined as the ratio between the share of sick people exposed to a risk factor and the share of sick people not exposed to a risk factor.

$$RR = \frac{p(\text{disease}\,|\,\text{exposed})}{p(\text{disease}\,|\,\text{not exposed})} = \frac{\text{sick obese} \,/\, \text{all obese}}{\text{sick non-obese} \,/\, \text{all non-obese}}$$

If, for example, two percent of the obese population suffer from diabetes mellitus, while only one percent of the non-obese individuals are affected by it, the RR of diabetes mellitus for obese individuals is 2. This would mean that obese people are twice as likely to suffer from diabetes mellitus as the others.

$$PAF = \frac{p(RR-1)}{p(RR-1)+1}$$

The population attributable fraction PAF is just a reformulation of the RR expressing the share of the prevalence of a disease that is attributable to a risk factor. For this calculation the prevalence p of the risk factor, i.e. the share of population that is exposed to a risk factor, has to be known as well as the RR of exposed individuals. In the above diabetes example with a double risk of diabetes mellitus for obese individuals (RR=2) and an assumed obese fraction p of 10% of the population, the share of diabetes mellitus that is attributable to obesity amounts to 9.09%.

There is an extensive literature reporting an association between overweight and obesity and their comorbidities. We only present the findings of two recent studies. In

their cost-of-illness (COI) study Schneider et al. (2009) report scientific evidence for 32 diseases linked to obesity. Guh et al. (2009) present in their systematic literature review evidence for 18 diseases meeting their quality criteria. Table 3 lists the diseases provided by the two studies. The RR reported by Guh et al. (2009) are usually smaller than those reported by Schneider et al. (2009).[9]

RR ratios measure the difference in the prevalence of a comorbidity between exposed and non-exposed individuals at one point in time. There is, however, a considerable time lag between changes in the body weight and the resulting health outcomes. For that reason it could be desirable to apply indicators of this association with respect to the time before the incidence of a health event. This requirement is met by the so called hazard ratio. Hazard Ratios describe the relative risk of a comorbidity as the ratio between the predicted hazard of an exposed individual and that of an individual not exposed to a risk factor. These predicted hazards are estimated by a regression analysis which also allows controlling for confounding factors. Nevertheless the use of basic RR factors is very common and all the cost of illness studies we referred to in this paper employ this approach. To be able to use published data for a Swiss CBA we therefore recommend the use of RR factors. RR factors estimated in regression analyses can also be adjusted for confounding factors, but can lead to biased PAF when the above formula is applied (Flegal et al. 2006).

[9] For some diseases, Schneider et al. (2009) do not provide RRs but odds ratios instead. If the disease is rare among the individuals not exposed to a risk factor, the OR provides a reasonable approximation of the RR. However, if the disease is common, the OR will exaggerate the RR (Viera 2008).

Table 3 Comorbidities of overweight and obesity and their relative risks

	Schneider et al. (2009)		Guh et al. (2009)
	relative risk	odds ratio	relative risk
hypertension		1.8-3.4	1.28-2.42
dyslipidemia (hypercholesterolemia, hypertriglyceridemia)	0.9-1.3		
diabetes mellitus Type 2	3.4-14.7		2.40-12.41
stroke		1.4-3.0	1.15-1.51
coronary heart disease (CHD)	1.33-2.44		
coronary artery disease			1.29-3.10
congestive heart failure			1.27-1.78
pulmonary embolism			1.91-3.51
breast cancer	1.12-1.25		1.08-1.13
colorectal cancer	1.03-1.47		1.45-1.95
colon cancer	1.06-1.55		
rectum cancer	1.09-1.19		
oesophagus cancer		1.5-2.4	1.13-1.21
pancreas cancer	1.07-1.25		1.24-2.29
liver cancer	1.09-1.19		
gall bladder cancer	1.09-2.53		
prostate cancer	1.03-1.06		1.05-1.14
kidney cancer	1.24-1.8		1.40-2.64
leukaemia	1.08-1.37		
non-Hodgkin’s lymphoma	1.06-1.14		
"multiple myeloma"	1.11-1.23		
endometrial cancer	1.59-2.53		1.53-3.22
ovarian cancer	1.03-1.06		1.18-1.28
thyroid cancer	1.14-1.77		
osteoarthritis			1.80-4.20
hip osteoarthritis		1.1-1.8	
knee osteoarthritis		2.1-5.4	
depression	1.3		
gallbladder disease/gallstones		1.86-3.38	1.09-2.32
sleep apnoea		1.74-4.17	
thromboembolism		1.3-2.5	
gout	1.95-2.33		
polycystic ovary syndrome (PCOS)	1.16-1.5		
miscarriage	1.26-1.37		
asthma	1.8-3.3		1.20-1.78
chronic kidney disease	1.5-2.4		
chronic back pain			1.59-2.81

4.1 Availability of Swiss data

It is important to note that there are no Swiss studies which calculate the RR of developing a comorbidity. Schneider et al. (2009) and Schneider and Schmid (2004) use RR from other Western countries in order to calculate the PAFs and the COI of comorbidities for Switzerland. A recent study by Marques-Vidal (2009) estimated the prevalence of some comorbidities (diabetes mellitus type 2, cancer, coronary heart disease, hypertension/dyslipidemia) with data from a Swiss health insurance company. Information on the prevalence of comordbidities is a precondition for the calculation of RR factors.

4.2 Quality of Swiss data

Based on the assumption that the biological interrelationships between risk factors and the consequential diseases are the same among members of western societies the use of foreign RR data in the Swiss context can be justified. However the nature of the underlying data affects the size of the calculated RR in many ways. As shown in section 3.1 the accuracy of overweight and obesity measures plays a decisive role in the calculation of the RR factors. The same is true for the measurement of the prevalence of the comorbidities. The state of the screening technology applied and the definitions of the stages of a disease can vary significantly between different studies or countries (Levine 2008).

These difficulties with the use of foreign RRs are confirmed by the fact that the RRs differ substantially in size for some diseases although they were extracted from the literature in the same time period.[10] A higher RR results in a higher PAF which then results in higher estimated costs of overweight and obesity and eventually leads to an overestimated return on investment of prevention and health promotion interventions as presumably more costs are avoided. The choice of RR will therefore affect the precision of a CBA so that this parameter must be part of the sensitivity analysis.

For the use of foreign RR factors the circumstances of their calculation have to be checked thoroughly. One main issue is the distribution of the body mass index that has to be similar to the Swiss situation. If foreign RRs do not seem applicable they have to be re-estimated based on Swiss data.

If the applied RR factors are calculated separately for every comorbidity, the overall effect of overweight and obesity on the secondary diseases may be overestimated since the relationships between the comorbidities are incorporated in the estimated RR as well. This can be remedied by a joint calculation of the RR (Guh et al. 2009) or by a weighting of the PAF (Marques-Vidal and Studer-Merkle 2009).

[10] It is also interesting to compare the RRs adopted by the two Swiss cost-of-illness studies (Schneider and Schmid 2004; Schneider et al. 2009) as over the intervening years an array of studies accounting for RRs was published.

5 Cost of illness of overweight and obesity and their comorbidities

For the benefit side of a CBA, the avoided costs thanks to prevention and health promotion interventions need to be known. Diseases can cause private and societal costs by the consumption of resources for medical treatment (direct costs), by reduced productivity of people involved (formerly known as indirect costs) and by reducing the lifetime and life quality of the affected individuals (intangible costs).

As mentioned above we consider obesity a disease as well as, together with overweight, a risk factor for other illnesses. Therefore it is important to incorporate both aspects in a cost-of-illness (COI) analysis. On the one hand the costs of excess body weight without any relation to a comorbidity have to be accounted for. On the other hand the costs of comorbidities that are attributable to overweight and obesity are to be calculated by the multiplication of the PAF with the total costs of a comorbidity extracted from COI studies.

5.1 Availability of Swiss data

5.1.1 Direct costs

The direct costs of a disease comprise the costs of medical services, non medical assistance, and administrative costs (health insurance, public administration).

Because diets without counselling and physical activity cannot be priced monetarily, Schneider et al. (2009) restrict the health care costs directly linked to overweight or obesity to slimming pills, to consultations with nutritionists and to bariatric surgery like gastric banding or a gastric bypass.

A broader array of medical cost information has to be taken into account when the comorbidities of overweight and obesity are concerned. Even though the set of comorbidities can be quite wide (Guh et al. 2009), Anis et al. (2009) narrowed it down to 18 comorbidities and Schneider et al. (2009) even confined themselves to consider only nine comorbidities. They chose those with high population attributable risks (Kopelman 2006) supplemented by other comorbidities if COI studies, preferably conducted in Switzerland, were available. The selection by Schneider et al. (2009) shown in Table 4 basically corresponds with the comorbidities emerging as the most expensive ones in the analysis by Anis et al. (2009). The listed Swiss COI studies refer to several official statistical sources of data about direct COI in Switzerland listed non-exhaustively in Table 5. Where there are no domestic COI-studies, the authors chose to translate foreign studies into the Swiss context.

Table 4 Selected COI studies of comorbidities of overweight and obesity

Comorbidity	Reference	country	type of cost	cost year	cost in Mio CHF in 2006
hypertension	Statistisches Bundesamt (2004)	D	Direct	2002	1470
diabetes (NIDDM)	Smala et al. (2001)	CH	Total	2000	2110
stroke	Jäger et al. (2008)	CH	Total	2004	502
coronary heart disease	Sagmeister et al. (1997)	CH	Total	1993	2891
breast cancer	Dedes et al. (2007)	CH	Direct	2006	160
colorectal cancer	Sieg and Brenner (2007)	D	Direct	2002	283
gallstones	Sandler et al. (2002)	US		1998	396
osteoarthritis (knee & hip)	Merx et al. (2007)	D	Total	2002	2148
depression	Jäger et al. (2008)	CH	Total	2004	9248
traffic accidents (sleep apnea)	Unfallstatistik (SSUV 2008)	CH	Direct	2006	413
asthma	Szucs et al. (1999)	CH	Total	1997	1763
chronic kidney disease	Happich et al. (2008)	D	Total	2002	19

Source: Schneider et al. (2009)

Table 5 Sources of direct cost data in Switzerland

Name of survey	Direct cost data	Institution	Frequency	Time
Kosten und Finanzierung des Gesundheitswesens	-expenses by funding agencies, and individuals -cost of hospitalisation	FSO, Population Health	Annual	Since 1985
Krankenhausstatistik	-hospital activities and services -staff -tariffs and prices	FSO, Health	Annual	Since 1997
VESKA Statistik	-hospitalized cases -inhospital deaths	H+ Die Spitäler der Schweiz	Annual	1970-1997
Medizinische Statistik der Krankenhäuser	-case data -patient characteristics -diagnoses and Treatments	FSO, Health	Annual	Since 1998
Swiss Health Survey (SHS)	-population health -living and working conditions -demand of health services -insurance situation	FSO, Population Health	Every 5 years	Since 1992
Statistik der Hilfe und Pflege zuhause (SPITEX)	-characteristics of SPITEX organizations	FSO, Health	Annual	Since 1997
Statistik der medizinisch unterstützten Fortpflanzung	-medically assisted procreation -patient data	FSO, Population Health	Annual	Since 2002
Statistik der sozialmedizinischen Institutionen (SOMED)	-facilities -staff -accounting -nursing homes -homes for troubled, ill and handicapped	FSO, Health	Annual	Since 1997
Statistik der Todesursachen und Totgeburten (eCOD)	-characteristics of deceased	FSO, Population Health	Annual	Since 1876
Statistik diagnosebezogener Fallkosten	-patient characteristics -diagnoses and treatment -cost per case	FSO, Health	Annual	Since 2005
Statistik über den legalen Schwangerschaftsabbruch	-patient characteristics -treatment	FSO, Population Health	Annual	Since 2006
Lohnerhebung	-salaries of hospital staff	H+ Die Spitäler der Schweiz	Every 2 years	Since 2007
Swiss reimbursement Catalogue	-cost per service activity	Tarmed Suisse		Since 2000
Statistik der Unfallversicherung UVG	-diagnosis and treatment -accident causes -cost distribution	Kommission für die Statistik der Unfallversicherung (KSUV)	Annual	Since 1984

5.1.2 Production losses

Besides the direct intervention costs of fatness and its comorbidities these conditions also cause production losses. These can result from lower productivity at work, absence from work, early retirement or from death before retirement. They may also include the replacement cost for a worker lost due to death or invalidity (hiring, training, initially lower productivity of substitutive labour). In addition to the production loss of overweight and obese people, individuals in their surroundings can also be less productive due to private care tasks.

While the Canadian cost estimations by Anis et al. (2009) include the production losses of all selected comorbidities, only some of the COI studies used by Schneider et al. (2009) incorporate this aspect (Sagmeister et al. 1997; Szucs et al. 1999; Smala et al. 2001; Sandler et al. 2002; Merx et al. 2007; Happich et al. 2008; Jäger et al. 2008). Only two of them also address the production loss of caring relatives (Sandler et al. 2002; Jäger et al. 2008). The production loss assigned to obesity itself is not discussed in any of the mentioned papers. In general the lost production of workers showing up at work in poor health is neglected as well.

The data needed to calculate an average production loss per case can be retrieved from official national and international sources. The Swiss Federal Statistical Office (FSO) and the Federal Social Insurance Office (FSIO) have available various data concerning labour force participation, wage situation, state pension, disability insurance and accident insurance. These sources can be used to value health related productivity information obtained from health specific datasets. For certain events the Swiss statistical yearbook already contains prepared aggregate calculations. On an international level the International Labour Organization (ILO) keeps an account of labour statistics, also covering Switzerland. This data is useful especially when comparability with foreign studies is desirable. Reoccupation costs due to the loss of an employee are dealt with in the report by Ecoplan (2006).

5.1.3 Intangible Costs

Intangible costs are the monetary representation of the loss in personal wellbeing of patients and their associates due to impaired health or premature death. Neither the calculations by Anis et al. (2009) nor the cost studies cited by Schneider et al. (2009) incorporate the intangible costs of overweight and obesity and their comorbidities. This is an important deficiency since individual pain and suffering of patients and their associates is not accounted for. A review of the established methods to assess the intangible costs of certain health outcomes is enclosed in our methodological review (Schmidhauser et al. 2008) One method at hand is the employment of disability adjusted life years (DALY), assessed by the World Health Organization for many health conditions, expressing the damage to an individual's life quality in terms of the number of life years of full health lost. This method and the monetary valuation of a life year is discussed in our methodological review in more detail (Schmidhauser et al. 2008).

5.2 Quality of Swiss data on the costs of overweight and obesity

The lack of Swiss COI studies for some comorbidities raises the question as to whether or not cost data collected in foreign health care systems is valid for the Swiss context. In general the validity is better if the cost estimations are conducted in countries with comparable socioeconomic structures and with health care systems similar to the Swiss model.

Another issue is the perspective taken in the available COI studies. If the costs of an illness are to be estimated from a societal point of view, medical costs, production losses and intangible costs should be considered. Many of the available COI studies, however, adopt the perspective of a service provider or a funding agency and only include health care expenses in their cost estimations. Therefore they fail to show the whole burden the diseases inflict upon society. Furthermore it is difficult to compare the COI of comorbidities if their estimates comprise different types of costs.

To improve the quality of the estimations of the costs of overweight and obesity it is therefore necessary to calculate the COI of their comorbidities based on Swiss data. A societal perspective is to be adopted. To ensure comparability of cost factors and for efficiency reasons it is recommended to estimate the COI of comorbidities in one single study and applying a common methodology, following the example of Anis et al. (2009).

With respect to the good statistical coverage of professional life in Switzerland the quality of estimations of production losses due to diseases ultimately hinges on the availability of information on the productivity related consequences of diseases in Swiss health data. One way forward would be to assess the production loss directly linked to overweight and obesity.

The health care expenses, the lost production or the intangible costs of a risk factor may be counted more than once if separately estimated COI of comorbidities are simply summed up. On the basis of published cost estimations it is very hard to identify the components that are subject to double counting. In most cases only few of the comorbidities the participants of COI studies suffer from are known and some of the considered treatments could be induced by several illnesses at a time.

6 Prevention and health promotion interventions

When evaluating the effectiveness of prevention and health promotion interventions, information on the number and quality of these interventions is required. In addition, costs of these interventions need to be known for the cost side of a cost-benefit-analysis.

6.1 Availability of Swiss data

Most prevention and health promotion interventions in Switzerland were not implemented before the start of the current decade. However in the last few years several projects were started. There are three main national organizations in Switzerland coordinating and financing interventions: Federal Office of Public Health (FOPH), Health Promotion Switzerland (HPS) and Federal Office of Sport (BASPO). Table 6 gives an overview of programmes wherein these institutions are involved.

Table 6 Overview of prevention and health promotion programmes in Switzerland

Name of programme	time period	involved institution			additional support from
		FOPH	HPS	BASPO	
National Programme for Nutrition and Physical Activity (NPEB)	2008-2012	x	x	x	Swiss Conference of the Cantonal Ministers of Public Health
suissebalance	2002-	x	x		
Healthy weight	2007-2010		x		
5 servings of fruit & vegetables a day	2001-	x	x		Swiss Cancer League
action d (diabetes prevention)	2001-		x		Three health insurances
Network Health-Enhancing Physical Activity (hepa)	1999-	x	x	x	Swiss Council for Accident Prevention

Besides these nationally coordinated programmes, there are several non federal institutions implementing interventions against overweight and obesity. They include cantonal ministries of public health as well as of education, municipalities, other federal offices, private organizations, and many more. Furthermore, the development of overweight and obesity has many causes which allow for a multitude of possible intervention strategies. For all these reasons, it might be a time-consuming task to detect all the relevant prevention and health promotion interventions in Switzerland which are initiated on different political levels and by different organizations.

Cost information on these programmes and its supported projects should be available from the institutions involved. Yet, since the projects are mostly co-financed by other institutions which are sometimes financed by their partners, the assessment of costs must be carefully performed in order to avoid double-counting.

Production losses and intangible costs due to these interventions are negligible for the current and past interventions. This could change if, for example, a tax on fatty food was implemented as such interventions might upset many (healthy) people.

Due to the complexity of the problem and the long time lag between unhealthy behaviour and the effects on health, proving the effectiveness of these interventions presents a difficult task. Swiss researchers reviewed the international literature several times (Federspiel et al. 2005; Jörin and Schluep Campo 2005; Eisenring et al. 2006; Galani and Schneider 2006; Schmidhauser and Brügger 2008) and show relatively scarce evidence for the (long-term) effectiveness of interventions in this prevention field. No study from Switzerland was included in these reviews, except the one by Galani et al. (2007) which uses however, only a hypothetical sample. Whether the findings can be adapted to Swiss interventions in a future CBA is doubtful, as they may differ substantially in terms of the specificities of their context. It is necessary to continuously monitor the Swiss projects so that an effectiveness study will be possible in the future. HPS is an example for this by monitoring and evaluating the projects of their programme Healthy Weight. However, it has to be noted that single projects may be evaluated not to be effective while a bundle of interventions may show a positive effect on body weight.

7 Conclusions / Recommendations

In this report we have presented and discussed the necessary preconditions for a cost-benefit analysis (CBA) in the field of overweight and obesity. For the analysis, two essential types of information are needed; information on the *costs of prevention measures*, and data about *the effectiveness of interventions*. The effectiveness is quantified by the number of avoided cases of overweight and obesity which are valued by the costs of these conditions. Prevalence measures of overweight and obesity are used for the calculation of the portions of comorbidities attributable to overweight and obesity. These population attributable fractions and data on the societal costs of the comorbidities are needed to show the costs of overweight and obesity as a risk factor. The benefit side of a CBA is completed by the avoided costs directly caused by overweight and obesity.

Since prevention interventions in Switzerland are carried out by many different governmental and non-governmental institutions and on different levels of the federal state, it is highly difficult to give a comprehensive overview over the existing interventions. Nevertheless it can be concluded that for most prevention measures only actions aimed at changes in the environment and in the behaviour of people are recorded but no information on the weight loss is collected. Detecting the effect of a prevention programme on body weight is difficult as the time lag between structural or behavioural changes and the health outcome is large which increases the distortion due to confounding factors. We recommend building up a central register of all prevention measures undertaken. Scientific support of prevention projects could help to collect the relevant effectiveness information in the first place.

Trends in the prevalence of overweight and obesity can best be estimated on the basis of the Swiss Health Survey (SHS). The SHS is representative for Switzerland and contains a lot of questions concerning personal health and medical service use. The only drawback is that only self-reported body mass information is collected. The Swiss Household Panel (SHP1 and SHP2) contains fewer participants and no measured body mass indicators are recorded either, but the longitudinal nature of the data allows to follow single individuals over time while controlling for explanatory and confounding factors. Furthermore, it is conducted yearly which allows to account for short-term variations in the prevalence of overweight and obesity. In order to explore causal pathways, however, it could be helpful to include more health data in the SHP. None of the reported surveys include adults and children at the same time. The SHS considers only participants older than 14 and in the SHP, proxy interviews with the parents are conducted but no body mass information is collected. Nevertheless, Zimmermann et al. (2004a) and Aeberli (2008) presented representative surveys of the 6-12 year old that could be appended to other surveys. After all both, the SHP and the SHS, are valid data sources for future research in the field of overweight and obesity and are highly complementary.

The bias of self-reported BMI can be corrected by the coefficients of a regression analysis of the relationship between measured and self-reported BMI. Therefore

objective and subjective body mass information have to be collected in a representative sample to estimate the correction equations. The measurement of weight and height could be conducted among a subpopulation of the SHS or the SHP or could be implemented into future surveys like the National Nutrition Survey Switzerland (NANUSS).

The population attributable fractions (i.e. the factors indicating what fraction of the prevalence of a disease is attributable to overweight or obesity) and their components are provided in the literature. The role of overweight and obesity in the development of other diseases, however, has not yet been understood completely. Only a limited set of comorbidities is covered sufficiently by the existing literature and the indicators of the relationship between fatness and its comorbidities vary substantially between different studies. This could be explained by differences in the population examined or by the time of data collection. Therefore it has to be checked thoroughly in each individual case if foreign and relatively old studies are applicable for the present Swiss context. Future research could produce more reliable evidence on the link between overweight and obesity and related diseases. Moreover, new findings of currently unidentified comorbidities would make CBA more comprehensive. In the Swiss context the accuracy of a CBA could be improved by the calculation of RR in a sample representative for Switzerland and its Cantons. A European project with the aim of conducting a joint estimation of the association between weight problems and other diseases could help to fix the problems of unadjusted RR factors from the literature.

The total societal costs of the comorbidities of overweight and obesity can be taken from published cost of illness (COI) studies or can be calculated on the basis of Swiss databases. The existing COI studies suffer from several deficiencies. All of the reviewed articles neglect the lost wellbeing of people affected by a comorbidity, some even only account for health care expenses. For many diseases related to overweight and obesity there are no COI studies conducted in Switzerland at this point. Considering the structural differences between national health systems, the use of foreign cost data is disputable. If the total costs of diseases in Switzerland are to be calculated from scratch, there are some sources publicly available to estimate healthcare costs per case. Concerning the production losses, extensive information is collected by governmental agencies. The intangible costs of diseases can be derived from the disability adjusted life years (DALY) issued by the WHO. These years of full health lost due to a disease can be valued by the monetary price of a life year of patients. Double counting of health care expenses, lost production and intangible costs is a serious problem that could be solved by a joint calculation

The commission of a Swiss COI study covering as many comorbidities as possible and including intangible costs of illnesses is advisable. In addition, the lost production and the reduced wellbeing of overweight or obese individuals not suffering from any comorbidities should be accounted for.

At this point, a prevention intervention can be evaluated economically once information on the reduction of overweight and obesity in the target group is

available. There are several obstacles to an assessment of the effectiveness of interventions. On a population level the intervention and control groups are hard to define which makes the identification of the achieved effect very difficult. If certain individuals are surveyed, they have to be tracked for a long period of time to allow observations of possible effects.

The quality of an economic evaluation hinges on the number of comorbidities considered and on the validity of the applied relative risk factors and the COI studies used.

Therefore we recommend the following steps:

- The effectiveness of prevention interventions has to be measured in terms of the number of reduced cases of overweight or obesity in the target group. This can be achieved by a central monitoring of prevention projects and consultancy on the data collection.
- Regularly updating literature reviews to keep track of the latest results on possible comorbidities and their relationship with overweight and obesity and on the costs of these illnesses.
- Launch of Swiss COI and RR studies of overweight and obesity and their comorbidities to improve the accuracy of the data employed in a CBA.
- Collection of measured height and weight data together with self-reported data at least in a representative subpopulation of a future survey in order to estimate an equation for the correction of biased self-reported body mass indices.
- Continual monitoring of the prevalence of overweight and obesity in order to establish coverage of long time spans needed to detect trends and effects of interventions. As indicator of the prevalence, maintaining the use of BMI but also monitoring the literature on other methods.

References

Aeberli, I. (2008). Nutritional risk factors for the metabolic syndrome in overweight children. Institute of Food Science and Nutrition. Zurich, ETH Zürich. **PhD Thesis**.

Anis, A. H., W. Zhang, et al. (2009). "Obesity and overweight in Canada: an updated cost-of-illness study." Obesity Reviews **In Press**

Baerlocher, K. and J. Laimbacher (2005). Ernährungsverhalten von St. Galler Schulkindern 1991/92 und 1998/99. In: M. Eichholzer et al. (Ed.^Eds.), Fünfter Schweizerischer Ernährungsbericht. Bern, BBL**:** 151-166.

Bärlocher, A. F. (2005). Prävalenz und Determinanten des Übergewichtes und der Adipositas bei St. Galler Kantonsschülern und Kantonsschülerinnen. Medizinische Poliklinik, Universitätsspital Zürich. Zürich, Universität Zürich. **Dissertation**.

Beer-Borst, S., A. Morabia, et al. (2000). "Obesity and other health determinants across Europe: The EURALIM Project." J Epidemiol Community Health **54**(6): 424-430

Bernstein, M. S., M. C. Costanza, et al. (2001). "Physical activity of urban adults: A general population survey in Geneva." Sozial- und Präventivmedizin/Social and Preventive Medecine **46**(1): 49-59

Bettoni, M. (2002). Prävalenz und Determinanten des Übergewichtes und der Adipositas bei 9-12 jährigen Primarschülern im Tessin: eine deskiptive Studie. Medizinische Poliklinik, Universitätsspital Zürich. Zürich, Universität Zürich. **Dissertation**.

Bhattacharya, J. and N. Sood (2007). "Health insurance and the obesity externality." Adv Health Econ Health Serv Res **17**: 279-318

Boström, G. and F. Diderichsen (1997). "Socioeconomic Differentials in Missclassification of Height, Weight and Body Mass Index Based on Questionnaire Data." International Journal of Epidemiology **26**(4): 860-866

Bringolf-Isler, B., L. Grize, et al. (2008). "Personal and environmental factors associated with active commuting to school in Switzerland." Preventive Medicine **46**(1): 67-73

Burkhauser, R. V. and J. Cawley (2008). "Beyond BMI: The value of more accurate measures of fatness and obesity in social science research." Journal of Health Economics **27**(2): 519-529

Canoy, D. (2008). "Distribution of body fat and risk of coronary heart disease in men and women." Curr Opin Cardiol **23**(6): 591-8

Canoy, D., S. M. Boekholdt, et al. (2007). "Body Fat Distribution and Risk of Coronary Heart Disease in Men and Women in the European Prospective Investigation Into Cancer and Nutrition in Norfolk Cohort: A Population-Based Prospective Study." Circulation **116**(25): 2933-2943

Cavadini, C., B. Decarli, et al. (2000). "Food habits and sport activity during adolescence: Differences between athletic and non-athletic teenagers in Switzerland." European Journal of Clinical Nutrition **54**(Suppl 1): S16-20

Chiolero, A., I. Peytremann-Bridevaux, et al. (2007). "Associations between obesity and health conditions may be overestimated if self-reported body mass index is used." Obes Rev **8**(4): 373-4

Cole, T. J., M. C. Bellizzi, et al. (2000). "Establishing a standard definition for child overweight and obesity worldwide: international survey." BMJ **320**(7244): 1240-

Conley, D. and R. Glauber (2007). "Gender, body mass, and socioeconomic status: new evidence from the PSID." Adv Health Econ Health Serv Res **17**: 253-75

Connor Gorber, S., M. Shields, et al. (2008). "The feasibility of establishing correction factors to adjust self-reported estimates of obesity." Health Rep **19**(3): 71-82

Connor Gorber, S., M. Tremblay, et al. (2007). "A comparison of direct vs. self-report measures for assessing height, weight and body mass index: a systematic review." obesity reviews **8**(4): 307-326

Currie, C., K. Hurrelmann, et al., Eds. (2000). Health and Health Behaviour among Young People. Health Policy for Children and Adolescents, World Health Organization.

Currie, C., C. Roberts, et al., Eds. (2004). Young people's health in context - Health Behaviour in School-aged Children (HBSC) study: international report from the 2001/2002 survey. Health Policy for Children and Adolescents, No. 4, World Health Organization.

Danubio, M. E., G. Miranda, et al. (2008). "Comparison of self-reported and measured height and weight: implications for obesity research among young adults." Econ Hum Biol **6**(1): 181-90

Darioli, R., J. Perdrix, et al. (2004). "La mesure du poids et du tour de taille: une précieuse source simple et peu coûteuse d'informations pour la prévention cardiovasculaire." Revue Médicale Suisse **530**

Decarli, B., C. Cavadini, et al. (2005). Habitudes alimentaires et ingestats de nutriments d'un groupe d'adolescents vaudois de 9 à 19 ans. In: M. Eichholzer et al. (Ed.^Eds.), Fünfter Schweizerischer Ernährungsbericht. Bern, BBL**:** 133-150.

Dedes, K. J., T. D. Szucs, et al. (2007). "Cost-effectiveness of trastuzumab in the adjuvant treatment of early breast cancer: a model-based analysis of the HERA and FinHer trial." Ann Oncol **18**(9): 1493-1499

Dual-Fleckenstein, C. and F. Gutzwiller (1991). Le consommateur et l'information nutritionelle. In: H. B. Stähelin et al. (Ed.^Eds.), Dritter Schweizerischer Ernährungsbericht. Bern, EDMZ**:** 502-515.

Ecoplan (2006). "Unfallkosten im Strassen- und Schienenverkehr: Aktualisierung für die Jahre 1991 bis 2004."

Egger, S., R. Wieland, et al. (2001). "Übergewicht und Adipositas im Kanton Zürich - Eine LuftiBus Studie." Praxis(90): 531-538

Egloff, C. P. (2007). Übergewicht und Adipositas bei Besuchern des Luftibus im Jahre 2003. Medizinische Poliklinik, Universitätsspital Zürich. Zürich, Universität Zürich**:** 54.

Eichholzer, M. (2002). "Körpergewicht der Schweizer Bevölkerung Eine Übersicht über aktuellen Studien und Literatur."

Eichholzer, M., F. Bernasconi, et al. (2005). "Ernährung in der Schweiz. Resultate der Schweizerischen Gesundheitsbefragung 2002." Praxis **94**: 1713-1721

Eichholzer, M., J. Lüthy, et al. (1999). "Epidemiologie des Übergewichts in der Schweiz: Resultate der Schweizerischen Gesundheitsbefragung 1992/93." Schweiz Med Wochenschr(129): 353-61

Eisenring, C., P. Strasser, et al. (2006). "Gesundheitsförderung Schweiz - Update Juni 2006. Aktualisierung der ökonomischen Literatur zu den Kernthemen "Gesundes Körpergewicht" und "Psychische Gesundheit - Stress"."

Elgar, F. J., C. Roberts, et al. (2005). "Validity of self-reported height and weight and predictors of bias in adolescents." Journal of Adolescent Health **37**(5): 371-375

Engstrom, J. L., S. A. Paterson, et al. (2003). "Accuracy of self-reported height and weight in women: an integrative review of the literature." Journal of Midwifery & Women's Health **48**(5): 338-345

Exl-Preysch, B.-M., P. Mühlemann, et al. (2005). Nutri-Trend-Studie 2000: Ernährungsgewohnheiten und Einstellungen zur Ernährung in der Schweiz: Ergebnisse einer repräsentativen Umfrage. In: M. Eichholzer et al. (Ed.^Eds.), Fünfter Schweizerischer Ernährungsbericht. Bern, BBL**:** 217-241.

Faeh, D., P. Marques-Vidal, et al. (2008). "Obesity in Switzerland: do estimates depend on how body mass index has been assessed?" Swiss Med Wkly **138**(13-14): 204-10

Federspiel, B., C. Eisenring, et al. (2005). "Gesundheitsförderung Schweiz - Kernthema "Gesundes Körpergewicht": ökonomische Perspektive."

Ferron, C., P. A. Michaud, et al. (1997). "L'activité sportive des jeunes en Suisse: pratiques, motivatins et liens avec la santé - Sports activities of Swiss youths: practices, motivations and links to health." Archives de Pédiatrie **4**(6): 568-576

Firmann, M., V. Mayor, et al. (2008). "The CoLaus study: a population-based study to investigate the epidemiology and genetic determinants of cardiovascular risk factors and metabolic syndrome." BMC Cardiovascular Disorders **8**(1): 6

Freedman, D. S., L. K. Khan, et al. (2005). "The Relation of Childhood BMI to Adult Adiposity: The Bogalusa Heart Study." Pediatrics **115**(1): 22-27

FSO (2008). "Swiss Health Survey 2007."

Galan, I., A. Gandarillas, et al. (2001). "[Validation of self-reported weight and height in an adolescent population]." Gac Sanit **15**(6): 490-7

Galani, C. and H. Schneider (2006). Effectiveness of preventive and therapeutic interventions in overweight and obesity. A health technology assessment. Bundesamt für Gesundheit.

Galani, C., H. Schneider, et al. (2007). "Modelling the lifetime costs and health effects of lifestyle intervention in the prevention and treatment of obesity in Switzerland." International Journal of Public Health **52**: 372-382

Galobardes, B., M. C. Costanza, et al. (2003). "Trends in risk factors for lifestyle-related diseases by socioeconomic position in Geneva, Switzerland, 1993-2000: Health inequalities persist." American Journal of Public Health **93**(8): 1302-1309

Gasser, T., P. Ziegler, et al. (1993). "The dynamics of growth of weight, circumferences and skinfolds in distance, velocity and acceleration." Ann Hum Biol **20**(3): 239-59

Giacchi, M., R. Mattei, et al. (1998). "Correction of the self-reported BMI in a teenage population." Int J Obes Relat Metab Disord **22**(7): 673-7

Guh, D., W. Zhang, et al. (2009). "The incidence of co-morbidities related to obesity and overweight: A systematic review and meta-analysis." BMC Public Health **9**(1): 88

Gutzwiller, F., R. E. Leu, et al. (1985a). "The Swiss Health Survey Project (SOMIPOPS): an example of a data collection effort from various sources." Soz Praventivmed **30**(2): 76-9

Gutzwiller, F., B. Nater, et al. (1985b). "Community-based primary prevention of cardiovascular disease in Switzerland: methods and results of the National Research Program (NRP 1A)." Prev Med **14**(4): 482-91

Guyan, M. S. (2003). Prävalenz und Determinanten von Übergewicht und Adipositas bei Bündner Primarschülern: gibt es Unterschiede zwischen Stadt und Land? Medizinische Poliklinik, Universitätsspital Zürich. Zürich, Universität Zürich. **Dissertation**.

Happich, M., R. Landgraf, et al. (2008). "The economic burden of nephropathy in diabetic patients in Germany in 2002." Diabetes Res Clin Pract **80**(1): 34-9

Heshka, S. and D. B. Allison (2001). "Is obesity a disease?" Int J Obes Relat Metab Disord **25**(10): 1401-4

Jäger, M., P. Sobocki, et al. (2008). "Cost of disorders of the brain in Switzerland." Swiss Medical Weekly **138**: 4-11

Jalkanen, L., J. Tuomilehto, et al. (1987). "Accuracy of self-reported body weight compared to measured body weight. A population survey." Scand J Soc Med **15**(3): 191-8

Janssen, I., P. T. Katzmarzyk, et al. (2004). "Waist circumference and not body mass index explains obesity-related health risk." Am J Clin Nutr **79**(3): 379-384

Jeanmaire, R. and B.-M. Exl (1998). Le consommateur et l'information nutritionelle: Résultats d'une enquête. In: BAG (Ed.^Eds.), Vierter Schweizerischer Ernährungsbericht. Bern, EDMZ**:** 226-235.

Jeffery, R. W. (1996). "Bias in reported body weight as a function of education, occupation, health and weight concern." Addict Behav **21**(2): 217-22

Jörin, R. and I. Schluep Campo (2005). Massnahmen gegen Übergewicht in verschiedenen Ländern: Literaturstudie zur Wirksamkeit staatlicher Interventionen. Zürich, Institut für Agrarwirtschaft.

Karzig, M. M. (2004). Prävalenz und Risikofaktoren des Übergewichtes bei Primarschülern in Rüti (ZH). Medizinische Poliklinik, Universitätsspital Zürich. Zürich, Universität Zürich. **Dissertation**.

King, A., B. Wold, et al. (1996). "The health of youth. A cross-national survey." WHO Reg Publ Eur Ser **69**: 1-222

Klipstein-Grobusch, K., A. Kroke, et al. (1998). "Reproducibility of self-reported past body weight." European Journal of Clinical Nutrition **52**(7): 525-528

Kopelman, P. (2006). "Health risks associated with overweight and obesity." Obesity Reviews **8**(1): 13-17

Kortt, M. A., P. C. Langley, et al. (1998). "A review of cost-of-illness studies on obesity." Clinical Therapeutics **20**(4): 772-779

Kuczmarski, M. F., R. J. Kuczmarski, et al. (2001). "Effects of age on validity of self-reported height, weight, and body mass index: findings from the Third National Health and Nutrition Examination Survey, 1988-1994." J Am Diet Assoc **101**(1): 28-34; quiz 35-6

Kuendig, H., E. Kuntsche, et al. (2007). "Befragung zum Gesundheitsverhalten von 11- bis 15-jährigen Schülerinnen und Schülern - Deskriptive Statistik der 2006 erhobenen Gesamtschweizer Daten."

Kuskowa-Wolk, A. and S. Rössner (1989). "The "true" prevalence of obesity. A comparison of objective weight and height measures versus self-reported and calibrated data." Scandinavian Journal of Primary Health Care **7**(2): 79-82

Kyle, U. G., M. P. Kossovskya, et al. (2007). "Overweight and obesity in a Swiss city: 10-year trends." Public Health Nutrition **10**: 914-919

Largo, R. H., D. Pfister, et al. (1989). "Significance of prenatal, perinatal and postnatal factors in the development of AGA preterm infants at five to seven years." Dev Med Child Neurol **31**(4): 440-56

Larson, M. R. (2000). "Social desirability and self-reported weight and height." Int J Obes Relat Metab Disord **24**(5): 663-5

Laureti, R. (2005). Übergewicht, Adipositas und Fettmasse: Prävalenz und Determinanten bei 7-16 jährigen Primar- und Sekundarschülern im Tessin. Medizinische Poliklinik, Universitätsspital Zürich. Zürich, Universität Zürich. **Dissertation**.

Levine, B. J. (2008). "The other causality question: estimating attributable fractions for obesity as a cause of mortality." Int J Obes **32**(S3): S4-S7

Luce, B. R. and A. Elixhauser (1990). Standards for the socioeconomic evaluation of health care services. Berlin, Springer-Verlag.

Lundborg, P., K. Bolin, et al. (2006). "Obesity and Occupational Attainment among the 50+ of Europe." Advances in Health Economics and Health Services Research **17**(1): 219 - 251

MacMinn, W., J. McIntosh, et al. (2007). "How much does obesity matter? Results from the 2001 Canadian Community health survey." Advances in Health Economics and Health Services Research **17**(1): 333-364

Madrigal, H., A. Sanchez-Villegas, et al. (2000). "Underestimation of body mass index through perceived body image as compared to self-reported body mass index in the European Union." Public Health **114**(6): 468-73

Marques-Vidal, P., M. Bochud, et al. (2008). "Prevalence of obesity and abdominal obesity in the Lausanne population." BMC Public Health **8**(1): 330

Marques-Vidal, P. and U. Studer-Merkle (2009). "Évaluation des données des assurés de l'assurance CSS sur les prévalences des personnes traitées et les coûts des maladies liées au surpoids et à l'obésité en Suisse."

Martin, B. W. (2002). "Physical activity related attitudes, knowledge and behaviour in the Swiss population: comparison of the HEPA Surveys 2001 and 1999." Schweizerische Zeitschrift für «Sportmedizin und Sporttraumatologie» **50**(4): 164-168

Martin, B. W., U. Mäder, et al. (1999). "Einstellung, Wissen und Verhalten der Schweizer Bevölkerung bezüglich körperlicher Aktivität: Resultate aus dem Bewegungssurvey 1999." Schweizerische Zeitschrift für «Sportmedizin und Sporttraumatologie» **47**(4): 165-169

Masheb, R. M. and C. M. Grilo (2001). "Accuracy of self-reported weight in patients with binge eating disorder." Int J Eat Disord **29**(1): 29-36

McAdams, M. A., R. M. Van Dam, et al. (2007). "Comparison of Self-reported and Measured BMI as Correlates of Disease Markers in U.S. Adults." Obesity **15**(1): 188-196

Menke, A., P. Muntner, et al. (2007). "Measures of Adiposity and Cardiovascular Disease Risk Factors[ast]." Obesity **15**(3): 785-795

Merx, H., K. E. Dreinhofer, et al. (2007). "Socioeconomic relevance of osteoarthritis in Germany." Z Orthop Unfall **145**(4): 421-9

Morabia, A., M. Bernstein, et al. (1997). "Community-Based Surveillance of Cardiovascular Risk Factors in Geneva: Methods, Resulting Distributions, and Comparisons with Other Populations." Preventive Medicine **26**(3): 311-319

Morabia, A. and M. C. Costanza (2005). "The Obesity Epidemic as Harbinger of a Metabolic Disorder Epidemic: Trends in Overweight, Hypercholesterolemia, and Diabetes Treatment in Geneva, Switzerland, 1993-2003." Am J Public Health **95**(4): 632-635

Morris, S. (2007). "The impact of obesity on employment." Labour Economics **14**(3): 413-433

Narring, F., A. Berthoud, et al. (1997). "Condition physique et pratiques sportives des jeunes dans le canton de Vaud."

Narring, F., A. Berthoud, et al. (1998). "Condition physique et pratiques sportives des jeunes dans le canton Vaud."

Narring, F., A. Tschumper, et al. (2004). "Gesundheit und Lebensstil 16 bis 20-Jähriger in der Schweiz (2002)." raison de santé 95b

Narring, F., A. Tschumper, et al. (1994). "Die Gesundheit Jugendlicher in der Schweiz. Bericht einer gesamtschweizerischen Studie über Gesundheit und Lebensstil 15–20 jähriger."

Nawaz, H., W. Chan, et al. (2001). "Self-reported weight and height: implications for obesity research." Am J Prev Med **20**(4): 294-8

Nedeltchev, K., M. Arnold, et al. (2005). "Vascular risk factors in the Swiss population." Journal of Neurology **252**(10): 1210-1216

Niederhammer, I., I. Bugel, et al. (2000). "Validity of self-reported weight and height in the French GAZEL cohort." International Journal of Obesity **24**(9): 1111-1118

Nieto-Garcia, F. J., T. L. Bush, et al. (1990). "Body mass definitions of obesity: sensitivity and specificity using self-reported weight and height." Epidemiology **1**(2): 146-52

Ogden, C. L., R. J. Kuczmarski, et al. (2002). "Centers for Disease Control and Prevention 2000 growth charts for the United States: improvements to the 1977 National Center for Health Statistics version." Pediatrics **109**(1): 45-60

Paccaud, F., V. Schlüter-Fasmeyer, et al. (2000). "Dyslipidemia and abdominal obesity: An assessment in three general populations." Journal of Clinical Epidemiology **53**(4): 393-400

Palta, M., R. J. Prineas, et al. (1982). "Comparison of self-reported and measured height and weight." Am J Epidemiol **115**(2): 223-30

Peixoto Mdo, R., M. H. Benicio, et al. (2006). "[Validity of self-reported weight and height: the Goiania study, Brazil]." Rev Saude Publica **40**(6): 1065-72

Pirie, P., D. Jacobs, et al. (1981). "Distortion in self-reported height and weight data." J Am Diet Assoc **78**(6): 601-6

Prentice, A. M. and S. A. Jebb (2001). "Beyond body mass index." Obesity Reviews **2**(3): 141-147

Renaud, A., F. Narring, et al. (2001). "Mapping adolescent health and lifestyles in a multi-state country: methodological aspects and first results." Sozial- und Präventivmedizin/Social and Preventive Medicine **46**(3): 161-171

Roberts, R. J. (1995). "Can self-reported data accurately describe the prevalence of overweight?" Public Health **109**(4): 275-284

Roussow, K., M. Senekal, et al. (2001). "The accuracy of self-reported weight by overweight and obese women in an outpatient setting." Public Health Nutrition **4**(1): 19-26

Rowland, M. L. (1990). "Self-reported weight and height." American Journal of Clinical Nutrition **52**(6): 1125-1133

Sagmeister, M., U. Gessner, et al. (1997). "An economic analysis of ischaemic heart disease in Switzerland." Eur Heart J **18**(7): 1102-1109

Sandler, R. S., J. E. Everhart, et al. (2002). "The burden of selected digestive diseases in the United States." Gastroenterology **122**(5): 1500-11

Santillan, A. A. and C. A. Camargo (2003). "Body mass index and asthma among Mexican adults: the effect of using self-reported vs measured weight and height." Int J Obes Relat Metab Disord **27**(11): 1430-3

Schlettwein-Gsell, D., H. Dirren, et al. (1991). Ernährung und Ernährungsstatus von 361 70–75-jährigen Betagten in drei Regionen der Schweiz (Bellinzona, Burgdorf und Yverdon). In: H. B. Stähelin et al. (Ed.^Eds.), Dritter Schweizerischer Ernährungsbericht. Bern, EDMZ**:** 255-279.

Schlettwein-Gsell, D., H. Dirren, et al. (1998). Die EURONUT-SENECA-Studie: Schweizerische Betagte im europäischen Vergleich. In: BAG (Ed.^Eds.), Vierter Schweizerischer Ernährungsbericht. Bern, EDMZ**:** 340-357.

Schlettwein-Gsell, D., A. Haveman-Nies, et al. (2005). Ernährungszustand und Sterberisiko alter Menschen im europäischen Vergleich: SENECA 1989-1999. In: M. Eichholzer et al. (Ed.^Eds.), Fünfter Schweizerischer Ernährungsbericht. Bern, BBL**:** 305-319.

Schmid, H., M. Delgrande Jordan, et al. (2008). "Der Konsum psychoaktiver Substanzen von Schülerinnen und Schülern in der Schweiz - Ausgewählte Ergebnisse einer Studie, durchgeführt unter der Schirmherrschaft der Weltgesundheitsorganisation (WHO)."

Schmidhauser, S. and U. Brügger (2008). "Gesundheitsförderung Schweiz - Update 2007. Aktualisierung der ökonomischen Literatur zum Kernthema "Gesundes Körpergewicht"."

Schmidhauser, S., S. Wieser, et al. (2008). "Review of methodological literature on economic evaluation of health promotion and prevention with focus on cost-benefit analysis." Project Report (Returns on Investment in Prevention and Health Promotion Measures in Switzerland)

Schmidt, M. I., B. B. Duncan, et al. (1993). "Validity of self-reported weight--a study of urban Brazilian adults." Rev Saude Publica **27**(4): 271-6

Schneider, H. and A. Schmid (2004). "Die Kosten der Adipositas in der Schweiz."

Schneider, H., W. Venetz, et al. (2009). Overweight and obesity in Switzerland - Part 1: Cost burden of adult obesity in 2007. Basel, HealthEcon.

Schulz, P. J., U. Hartung, et al. (2007). "Ernährung, Körperbewegung und Körpergewicht - Einstellungen und Wahrnehmungen der Schweizer Bevölkerung - Ausführlicher Bericht über die Ergebnisse einer Befragung (Nullmessung) vor Beginn einer Kampagne der Gesundheitsförderung Schweiz."

Schutz, Y. and V. Woringer (2002). "Obesity in Switzerland: a critical assessment of prevalence in children and adults." International Journal of Obesity **26**(Suppl 2): S3-S11

Sebo, P., S. Beer-Borst, et al. (2008). "Reliability of doctors' anthropometric measurements to detect obesity." Preventive Medicine **In Press, Corrected Proof**

Shen, W., M. Punyanitya, et al. (2006). "Waist Circumference Correlates with Metabolic Syndrome Indicators Better Than Percentage Fat." Obesity **14**(4): 727-736

Sieg, A. and H. Brenner (2007). "Cost-saving analysis of screening colonoscopy in Germany." Z Gastroenterol **45**(9): 945-51

Simpson, J. A., R. J. MacInnis, et al. (2007). "A Comparison of Adiposity Measures as Predictors of All-cause Mortality: The Melbourne Collaborative Cohort Study." Obesity **15**(4): 994-1003

Smala, A., I. Beeler, et al. (2001). "Die Kosten der körperlichen Inaktivität in der Schweiz."

Snijder, M. B., M. Visser, et al. (2002). "The prediction of visceral fat by dual-energy X-ray absorptiometry in the elderly: A comparison with computed tomography and anthropometry." International Journal of Obesity **26**(7): 984-993

Spencer, E. A., P. N. Appleby, et al. (2002). "Validity of self-reported height and weight in 4808 EPIC–Oxford participants." Public Health Nutrition **5**(4): 561-565

SSUV (2008). Unfallstatistik UVG 2008, Sammelstelle für die Statistik der Unfallversicherung UVG.

Stamm, H., U. Ackermann, et al. (2007). "Monitoring der Gewichtsdaten der schulärztlichen Dienste der Städte Basel, Bern und Zürich - Schlussbericht zur Auswertung der Daten des Schuljahres 2005/2006."

Stamm, H., U. Ackermann, et al. (2008a). "Monitoring der Gewichtsdaten der schulärztlichen Dienste der Städte Basel, Bern und Zürich - Bericht zur Auswertung der Daten des Schuljahres 2006/2007."

Stamm, H., U. Ackermann, et al. (2009). "Monitoring der Gewichtsdaten der schulärztlichen Dienste der Städte Basel, Bern und Zürich - Auswertung der Daten des Schuljahres 2007/2008."

Stamm, H., M. Studer, et al. (2008b). "Analyse von Monitoring-Projekten in den Themenbereichen Ernährung und Bewegung in der Schweiz."

Statistisches Bundesamt (2004). Krankheitskosten 2002. Wiesbaden.

Steiner, L. K. H. (2003). Prävalenz und Determinanten des Übergewichts und der Adipositas bei 5- bis 6-jährigen Vorschulkindern. Medizinische Poliklinik, Universitätsspital Zürich. Zürich, Universität Zürich. **Dissertation**.

Stettler, N., T. M. Signer, et al. (2004). "Electronic games and environmental factors associated with childhood obesity in Switzerland." Obesity Research **12**(6): 896-903

Stewart, A. L. (1982). "The reliability and validity of self-reported weight and height." J Chronic Dis **35**(4): 295-309

Stolk, R. P., P. Suriyawongpaisal, et al. (2005). "Fat distribution is strongly associated with plasma glucose levels and diabetes in Thai adults—the InterASIA study." Diabetologia **48**(4): 657-660

Stutzer, A. (2007). "Limited Self-Control, Obesity and the Loss of Happiness." IZA Discussion Papers

Suter, P. M., R. Maire, et al. (1997). "Alcohol consumption: a risk factor for abdominal fat accumulation in men." Addiction Biology **2**(1): 101-103

Suter, P. M., B. Weissner, et al. (1993). "Heureka-Studie: Prävalenz des Übergewichts und der Adipositas in der Schweiz." Schweiz Rundsch Med Prax **82**(47): 1359-62

Szucs, T. D., H. Anderhub, et al. (1999). "The economic burden of asthma: direct and indirect costs in Switzerland." Eur Respir J **13**(2): 281-6

Thaler, T. A. (2005). Prävalenz von Übergewicht und Adipositas bei Gymnasiasten: Determinanten und Einflussfaktoren auf das Körpergewicht und die Körperzusammensetzung. Medizinische Poliklinik, Universitätsspital Zürich. Zürich, Universität Zürich. **Dissertation**.

Viera, A. J. (2008). "Odds ratios and risk ratios: what's the difference and why does it matter?" South Med J **101**(7): 730-4

Villanueva, E. V. (2001). "The validity of self-reported weight in US adults: a population based cross-sectional study." BMC Public Health **1**(11)

Wietlisbach, V., F. Paccaud, et al. (1997). "Trends in Cardiovascular Risk Factors (1984-1993) in a Swiss Region: Results of Three Population Surveys." Preventive Medicine **26**(4): 523-533

Wooldridge, j. m. (2003). Introductory Econometrics: A Modern Approach. Mason, South-Western.

Woringer, V. and Y. Schütz (2003). "Obésité en Suisse: percentiles d'indice de masse corporelle (IMC) d'une population d'enfants et d'adolescents nés en 1980 à Lausanne et écart avec les normes suisses (1955)." Sozial- und Präventivmedizin/Social and Preventive Medecine **48**(2): 121-132

Yusuf, S., S. Hawken, et al. (2005). "Obesity and the risk of myocardial infarction in 27'000 participants from 52 countries: a case-control study." The Lancet **366**(9497): 1640-1649

Zimmermann, M., C. Gübeli, et al. (2004a). "Overweight and obesity in 6–12 year old children in Switzerland." Swiss Medical Weekly **134**: 523-528

Zimmermann, M. B., C. Gubeli, et al. (2004b). "Detection of overweight and obesity in a national sample of 6-12-y-old Swiss children: accuracy and validity of reference values for body mass index from the US Centers for Disease Control and Prevention and the International Obesity Task Force." Am J Clin Nutr **79**(5): 838-843

Zimmermann, M. B., S. Y. Hess, et al. (2000). "A national study of the prevalence of overweight and obesity in 6-12 y-old Swiss children: body mass index, body-weight perceptions and goals." European Journal of Clinical Nutrition **54**(7): 568-572

Appendix I: Determinants of the bias in self-reported data

Along with the general underestimation of body mass on the basis of self-reported data there seem to be differences in the reporting behaviour of different groups of individuals. It is important to keep the determinants of the reporting behaviour in mind when conducting cost-benefit analyses of prevention measures in certain subpopulations or when trying to estimate the "true" values of respondents' body mass.

Gender

Though some studies find significant differences between men and women in the assessment of their body dimensions, this notion is neither supported quantitatively by the Review of Connor Gorber et al. (2007) nor are the results of the surveyed papers very uniform. Overall, men rather seem to overestimate their height while the underreporting of weight by women is apparently more pronounced.[11] The evidence of the effects of gender on the underestimation of BMI and the resulting misclassification of individuals, however, is inconsistent (Kuskowa-Wolk and Rössner 1989; Boström and Diderichsen 1997; Larson 2000; Niederhammer et al. 2000; Galan et al. 2001; Santillan and Camargo 2003; Peixoto Mdo et al. 2006; Danubio et al. 2008).

Age

In the analysis by Niederhammer et al. (2000) age was only associated with the bias in self-reported weight, but in opposite directions for men and women.[12] Other authors report that the bias in self-reported height also increases with age (Rowland 1990; Roberts 1995; Boström and Diderichsen 1997; Spencer et al. 2002; Connor Gorber et al. 2008). Kuczmarski et al. (2001) and Spencer et al. (2002) confirm these results with respect to the combined measure of BMI which is more underestimated the older the interviewed subjects are. The increasing bias with age has especially important implications for longitudinal studies. It has to be remarked that the effect of age on the misclassification bias can come from the height loss in old age which respondents may not be aware of.

Socioeconomic status

A comparison between three socioeconomic groups in a Swedish sample (1. manual workers, 2. low non-manual workers, 3. professionals and intermediate non-manual workers) reveals that manual workers overestimated their height more than non-manual workers while non-manual workers underestimated their weight more than manual workers (Boström and Diderichsen 1997). The consequential underestimation of BMI was lower for male but higher for female manual workers.

[11] Madrigal et al. (2000) get a contrary result concerning weight.

[12] By contrast (Spencer et al. 2002) did not find any variation of the underestimation of weight with age and Boström and Diderichsen (1997) report a decreasing underestimation of weight with age.

Nawaz et al. (2001) find that unemployed, retired or disabled women in the United States are more likely to underreport their BMI than employed women. A survey among French employees of a national energy company also indicates that the underestimation of body mass may be weaker for people of higher educational or occupational status (Niederhammer et al. 2000).[13] In a subsequent study the negative effect of education on the reporting bias is confirmed by a multivariate regression analysis (Santillan and Camargo 2003).

Overweight status

There is general consent in the literature that overweight and obese individuals are inclined to underreport their weight (Rowland 1990; Schmidt et al. 1993; Roberts 1995; Niederhammer et al. 2000; Spencer et al. 2002). Height is also considered to be more likely over-reported by individuals with higher BMI (Rowland 1990), according to Spencer et al. (2002) mainly due to a larger bias for short men and heavier women. The misreporting of these two details leads two significantly underestimated body mass indices for overweight and obese people (Santillan and Camargo 2003). Rowland (1990) points out that body mass information received from overweight subjects is not only more biased but also less reliable. On the other hand patients who are already under medical treatment because of an eating disorder may report their data quite accurately since they are more aware of their actual weight (Masheb and Grilo 2001).

[13] Some authors, however, found an increased bias in reporting of height (Nieto-Garcia et al. 1990) or weight (Pirie et al. 1981; Palta et al. 1982; Stewart 1982; Jalkanen et al. 1987; Nieto-Garcia et al. 1990; Jeffery 1996) with higher education.

Table I. 1 Correction equations to adjust self-reported estimates of weight, height and body mass index (BMI), by sex, Full and Reduced Models, household population aged 18 years or older, 2005

Men	
Full Model 1	Weight(measured) = -0.30+1.01(weightself-reported)+0.54(age 25- 34) +0.39(age 35-44)+0.50(age 45-54)+1.69(age 55-64) +0.83(age 65-74)+0.39(75 or older)+1.16(overweight) -1.52(underweight) Height(measured) = 12.17+0.93(heightself-reported)-1.48(age 25-34) -0.43(age 35-44)-1.23(age 45-54)-2.44(age 55-64) -2.87(age 65-74)-2.84(75 or older)+2.22(life dissatisfaction)
Full Model 2	BMI(measured) = -0.67+1.04(BMIself-reported)+0.64(age 25-34) +0.31(age 35-44)+0.39(age 45-54)+1.28(age 55-64) +1.16(age 65-74)+0.86(75 or older)-0.97(life dissatisfaction) -0.73(underweight)
Reduced Model 3	Weight(measured) = -2.19+1.05(weightself-reported) Height(measured) = 7.70+0.95(heightself-reported)
Reduced Model 4	BMI(measured) = -1.08+1.08(BMIself-reported)
Women	
Full Model 1	Weight(measured) = -1.25+1.04(weightself-reported)+1.25(overweight) +0.52(end-digit preference) Height(measured) = 14.85+0.91(heightself-reported)-1.20(age 25-34) -0.87(age 35-44)-0.59(age 45-54)-1.34(age 55-64) -1.42(age 65-74)-3.79(75 or older)-0.32(ethnicity E/SE Asian) -0.73(ethnicity other)-0.66(activity limitation)
Full Model 2	BMI(measured) = 1.01+1.01(BMIself-reported)-0.91(secondary graduation) -0.32(some postsecondary)-0.53(postsecondary graduation) +0.70(overweight)+0.29(end-digit preference)
Reduced Model 3	Weight(measured) = -2.14+1.07(weightself-reported) Height(measured) = 8.05+0.95(heightself-reported)
Reduced Model 4	BMI(measured) = -0.12+1.05(BMIself-reported)

Source: Connor Gorber et al. (2008)