

Body mass index, blood pressure, and serum cholesterol in young Swiss men: an analysis on 56 784 army conscripts

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Summary

Questions under study: This study aimed to investigate the prevalence of excess bodyweight and high blood pressure in young Swiss men and to evaluate the associations of these disorders with serum cholesterol in this important population.

Methods: The study investigated a large cohort of 56 784 Swiss army conscripts aged 18–25 years from 2004 through to 2007.

Results: From the investigated men, 2231 (3.9%) were underweight with a body mass index (BMI) <18.5 kg/m², 42 681 (75.2%) were normal weight (BMI 18.5–24.9 kg/m²), 9562 (16.8%) were overweight (BMI 25.0–29.9 kg/m²), and 1811 (3.2%), 402 (0.7%) and 96 (0.2%) had obesity classes I, II or III, respectively. The prevalence of blood pressure within the hypertensive range significantly increased through these categories of BMI (12.5%, 23.9%, 37.6%, 49.7%, 56.7%, and 54.2%), as did serum levels of cholesterol (3.8 ± 0.6, 4.0 ± 0.7, 4.4 ± 0.8, 4.7 ± 0.9, 4.7 ±

0.9, and 4.8 ± 1.1 mmol/l). Serum cholesterol also increased through categories of blood pressure (4.0 ± 0.7 mmol/l in normotensive subjects and 4.1 ± 0.7, 4.2 ± 0.8, and 4.5 ± 0.9 in those with blood pressure in the ranges of pre-hypertension, and hypertension stages 1 and 2, respectively); excess body weight and blood pressure in the hypertensive range were associated with serum cholesterol in a mutually independent manner.

Conclusions: Prevalence rates of excess bodyweight and of elevated blood pressure are high in young Swiss men, and these entities are strongly interrelated. Excess body weight and high blood pressure are independently associated with high serum cholesterol in this population. Excess bodyweight and associated risk factors should receive increased attention in young Swiss men.

Key words: body mass index; obesity; blood pressure; hypertension; cholesterol

Introduction

Western societies are facing an epidemic of obesity, with major implications on health care systems [1]. The prevention and treatment of obesity is a paramount aspect of cardiovascular disease prevention in clinical practice [2]. However, the prevalence rates of excess bodyweight and obesity have been increasing in adults and also in adolescents during the last several decades [3–11].

Whereas the prevalence of excess body weight is typically lower among adolescents than among adults [12], exposure to the obese state early in life strongly increases the risk of obesity-related complications such as diabetes mellitus or cardiovascular disease in middle age [13]. Further, obesity during the second decade of life is an important predictor of adult obesity [14–16].

Young individuals aged around 20 years are a particularly important group with respect to the study of cardiovascular risk factors. This is the age of the transition from adolescence to young adulthood where, in parallel to changes in working and social status, alterations in life-style typically occur. Interventions at this age may be particularly effective to decrease the burden of cardiovascular disease later in life.

The association of a high BMI with cardiovascular disease is at least partly explained by the association of BMI with cardiovascular risk factors such as hypertension and elevated serum cholesterol [17]. However, hardly any previous studies have addressed the associations of excess body weight with hypertension in adolescents or

young adults, and no data are available on the association of serum cholesterol with body weight in this age cohort.

This study therefore aimed to provide current estimates of the prevalence of excess body-weight and obesity, as well as of elevated blood

pressure, in a large unselected series of young men undergoing medical examination prior to entering service in the Swiss army. This study also aimed to evaluate the associations of these entities with each other and with serum levels of cholesterol.

Patients and methods

The data for the present investigation were extracted from the database containing the Swiss conscription health examinations. Military service is compulsory for young men in Switzerland, and with conscription (usually between the ages of 18 and 25 years) young Swiss men are subjected to a thorough medical investigation. The database of these conscription health examinations contains information on 95% of the age cohort; information is missing in less than 5% due to severe illness precluding individuals from participation in the conscription examination. In such cases, a written medical record from a physician is required.

Starting from January 1, 2004, a comprehensive medical examination was introduced for Swiss conscripts, which includes a voluntary laboratory testing (to which more than half of the conscripts consent). Blood was taken at the conscription centres in the fasting or in the non-fasting state, and was shipped to a laboratory centre in Basel, Switzerland, to be tested generally within 12 hours of sampling. Total cholesterol was measured by enzymatic assay on Cobas Integra 800 (Roche, Rotkreuz Switzerland) [18] and Bayer Advia 1650 (Siemens Diagnostics, Zurich Switzerland) [19]. In the main analysis, 56784 conscripts for whom serum cholesterol was measured from 2004 through to 2007 were included. Including participants who refused blood cholesterol measurement, anthropometric data and blood pressure are also reported for a total of 101844 conscripts. Written informed consent was obtained from all study participants.

The height of the enrolled conscripts, who were bare-footed and wore only underwear, was measured with a standard anthropometer, and their weight was recorded with a scale. The body mass index (BMI) was calculated as body weight (kg) / height² (m²). According to current BMI classifications for adults, the following categories of BMI were built: <18.5 kg/m² (underweight), 18.5–24.9 kg/m² (normal weight), 25.0–29.9 kg/m² (overweight), 30–34.9 kg/m² (class I obesity), 35–40 kg/m² (class II obesity), and ≥40 kg/m² (class III obesity).

Blood pressure was measured with the Riva-Rocci method in a sitting position after at least 5 minutes at rest. Following the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure (JNC) VII guidelines (20), blood pressure was considered normal when systolic blood pressure was <120

and diastolic blood pressure was <80 mm Hg. Blood pressure was categorized to be in the pre-hypertension, stage 1 hypertension, and stage 2 hypertension ranges when systolic / diastolic blood pressure were 120–139 / 80–90, 140–159 / 90–99, and ≥160 / ≥100 mm Hg, respectively. When systolic and diastolic blood pressure fell within different blood pressure categories, the subject was allocated to the higher one of these categories. In our study cohort, the last digits were 0, 1, 2, 3, 4, 5, 6, 7, 8, and 9 in 33.7%, 5.0%, 6.2%, 5.8%, 6.5%, 12.6%, 7.1%, 6.6%, 8.6%, and 7.8% of cases for systolic blood pressure and in 30.1%, 6.1, 7.1%, 6.2%, 6.7%, 13.5%, 7.1%, 6.8%, 9.8%, and 6.5% of cases for diastolic blood pressure, indicating a last digit preference which is to be expected in any study where blood pressure readings are taken manually.

Statistical analysis

Continuous study variables were tested for normal distribution by inspection of histograms and by using Kolmogorov-Smirnov tests. For two-group comparisons, differences in study variables for categorical variables were tested for statistical significance with Chi-squared tests, and for continuous variables with Mann-Whitney-U tests. For trends over categories we used Mantel-Haenszel Chi-squared tests for categorical variables and ordered Jonckheere-Terpstra tests for continuous variables. Analysis of covariance (ANCOVA) was performed using a general linear model approach to test independent associations of continuous and dichotomous variables with continuous variables for statistical significance (in particular, the mutually independent impact of BMI and high blood pressure on cholesterol was derived from an ANCOVA model). Linear regression models were built to study the association between continuous variables. Prior to being entered into these models variables were z-transformed, and standardized beta-coefficients are reported together with 95% confidence intervals and with corresponding p-values. Results are given as mean ± standard deviation if not denoted otherwise. P-values <0.05 were considered significant. All statistical analyses were performed with the software package SPSS 11.0 for Windows (Chicago, IL, USA).

The study is in accordance with the Helsinki Declaration and adheres to the legal requirements of the study country.

Results

Distribution of BMI and blood pressure

Important characteristics of our study population are summarized in table 1. The mean age of the included 56784 male conscripts was 19.7 ± 1.0 years (age range 18–25 years), and their mean BMI was 23.0 ± 3.3 kg/m². Overall, BMI was <18.5 kg/m² in 2231 (3.9%), 18.5–24.9 kg/m² in 42681

(75.2%), 25.0–29.9 kg/m² in 9562 (16.8%), 30.0–34.9 kg/m² in 1811 (3.2%), 35–40 kg/m² in 402 (0.7%) and ≥40 kg/m² in 96 (0.2%) conscripts.

Mean systolic and diastolic blood pressure were 130 ± 15 and 76 ± 11 mm Hg, respectively. Blood pressure was normal (systolic blood pressure <120 and diastolic blood pressure <80

Table 1

Important characteristics of the study population.

N	56784
Age (years)	19.7 ± 1.0
BMI (kg/m ²)	23.0 ± 3.3
BMI categories	<18.5 kg/m ² (n; %)
	2231 (3.9%)
	18.5–24.9 kg/m ² (n; %)
	42 681 (75.2%)
	25.0–29.9 kg/m ² (n; %)
	9562 (16.8%)
	30.0–34.9 kg/m ² (n; %)
	1811 (3.2%)
	35–40 kg/m ² (n; %)
	402 (0.7%)
	≥40 kg/m ² (n; %) 96 (0.2%)
Systolic blood pressure (mm Hg)	130 ± 15
Diastolic blood pressure (mm Hg)	76 ± 11
Blood pressure categories	Normal (n; %)
	6661 (11.7%)
	Pre-hypertension range (n; %)
	34 863 (61.4%)
	Stage 1 hypertension range (n; %)
	14 327 (25.2%)
	Stage 2 hypertension range (n; %)
	933 (1.6%)
Serum cholesterol (mmol/l)	4.1 ± 0.8
Serum cholesterol categories	Cholesterol >5.2 mmol/l (n; %)
	3927 (6.9%)
	Cholesterol >6.2 mmol/l (n; %)
	519 (0.9%)

Table 2

Blood pressure and serum cholesterol in BMI categories.

BMI (kg/m ²)	<18.5	18.5–24.9	25.0–29.9	30.0–34.9	35–40	≥40
All subjects						
N	2232	42 681	9562	1811	402	96
Systolic BP (mm Hg)	125 ± 14	130 ± 15	134 ± 16	137 ± 17	138 ± 19	138 ± 20
Diastolic BP (mm Hg)	75 ± 11	76 ± 10	78 ± 11	80 ± 12	82 ± 12	83 ± 13
Hypertension (%)	12.5	23.9	37.6	49.7	56.7	54.2
Cholesterol (mmol/l)	3.8 ± 0.6	4.0 ± 0.7	4.4 ± 0.8	4.7 ± 0.9	4.7 ± 0.9	4.8 ± 1.1
Cholesterol >5.2 mmol/l	1.9	4.9	13.2	23.2	24.6	25.0
Cholesterol >6.2 mmol/l	0.1	0.5	2.0	3.6	5.2	8.3

mm Hg) in only 6661 conscripts (11.7%); and 34 863 (61.4%), 14 327 (25.2%), and 933 (1.6%) had blood pressure in the pre-hypertension (systolic blood pressure 120–139 mm Hg; diastolic blood pressure 80–90 mm Hg), stage 1 hypertension (systolic blood pressure 140–159 mm Hg; diastolic blood pressure 90–99 mm Hg), or stage 2 hypertension (systolic blood pressure ≥160 mm Hg; diastolic blood pressure ≥100 mm Hg) ranges, respectively.

Additionally, when conscripts who did not participate in voluntary laboratory testing were included in the analyses, the distributions of BMI and blood pressure in a total of 101 844 conscripts were very similar: Their mean BMI was 23.0 ± 3.6 kg/m² and BMI was <18.5 kg/m² in 4739 (4.7%), 18.5–24.9 kg/m² in 75 476 (74.1%), 25.0–29.9 kg/m² in 16 960 (16.7%), 30.0–34.9 kg/m² in 3502 (3.4%), 35–40 kg/m² in 889 (0.9%) and ≥40 kg/m² in 278 (0.3%). Mean systolic blood pressure was 132 ± 16 mm Hg and mean diastolic blood pressure 77 ± 11 mm Hg. Blood pressure was normal (systolic blood pressure <120 and diastolic blood pressure <80 mm Hg) in 11 704 (11.5%); and 60 172 (59.1%), 25 837 (25.4%), and 4131 (4.1%) had blood pressure in the pre-hypertension (sys-

tolic blood pressure 120–139 mm Hg; diastolic blood pressure 80–89 mm Hg), stage 1 hypertension (systolic blood pressure 140–159 mm Hg; diastolic blood pressure 90–99 mm Hg), or stage 2 hypertension (systolic blood pressure ≥160 mm Hg; diastolic blood pressure ≥100 mm Hg) ranges, respectively.

Association between BMI and blood pressure

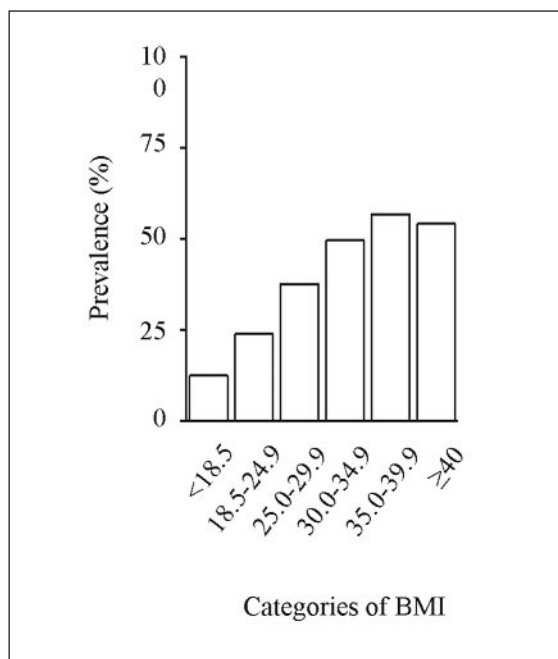
As summarized in table 2, systolic as well as diastolic blood pressure strongly and significantly increased through the categories of BMI ($p_{\text{trend}} < 0.001$ for both). Concordantly, the prevalence of high blood pressure significantly increased through these BMI categories (fig. 1; $p_{\text{trend}} < 0.001$).

BMI, blood pressure and serum cholesterol

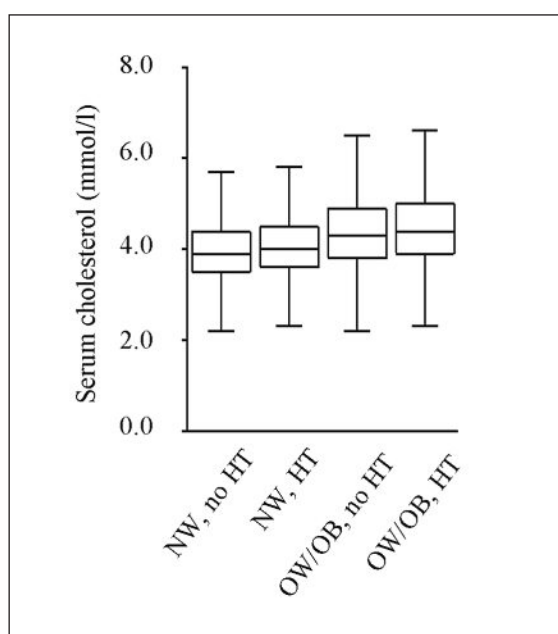
Mean serum cholesterol in the study population was 4.1 ± 0.8 mmol/l; it was >5.2 mmol/l in 6.9% of the investigated men and >6.2 mmol/l in 0.9%. Serum cholesterol increased significantly by 20.8% through increasing categories of BMI (table 2; $p_{\text{trend}} < 0.001$) as well as (by 12.5%) through blood pressure categories (table 3; $p_{\text{trend}} < 0.001$).

Figure 1

Prevalence of hypertension in categories of body mass index. BMI denotes body mass index; it is given in kg/m²; bar graphs are given showing the prevalence of hypertension in categories of BMI.

**Figure 2**

Body mass index, hypertension, and serum cholesterol. NW, no HT denotes the group with normal weight that does not have hypertension, NW, HT denotes the normal weight group with hypertension, OV/OB, no HT denotes the overweight / obese group without hypertension, and OV/OB, HT denotes the group with overweight / obesity plus hypertension.



From the 44913 normal-weight men 10484 had blood pressure values in the hypertensive range ($\geq 140/90$ mm Hg) according to JNC VII guidelines, and from the 11871 men who were overweight or obese, 4776 had blood pressure $\geq 140/90$ mm Hg. Figure 2 shows serum cholesterol values with respect to both the presence of excess body weight and high blood pressure: Serum cholesterol was lowest (4.0 ± 0.7 mmol/l) in normal-weight subjects with blood pressure $<140/90$ mm Hg, it was significantly higher in normal-weight subjects with blood pressure $\geq 140/90$ mm Hg (4.1 ± 0.7 mmol/l; $p < 0.001$) as well as in subjects with blood pressure $<140/90$ mm Hg who were overweight or obese (4.4 ± 0.8 mmol/l; $p < 0.001$), and highest in subjects with blood pressure $\geq 140/90$ mm Hg who were overweight or obese (4.5 ± 0.8 mmol/l; $p < 0.001$ for the comparison with all other groups). Analysis of covariance, after adjustment for age, confirmed that both excess bodyweight, or obesity ($F = 2407.1$; $p < 0.001$), and the presence of blood pressure $\geq 140/90$ mm Hg ($F = 141.8$; $p < 0.001$) were associated with serum cholesterol in a mutually independent manner.

Table 4 summarizes the results of linear regression analyses modelling associations between serum cholesterol, BMI, and systolic as well as diastolic blood pressure. These models showed that the association between serum cholesterol and BMI was stronger than that between serum cholesterol and blood pressure. However, the associations between serum cholesterol and systolic as well as diastolic blood pressure remained significant after adjustment for BMI. Taking systolic and diastolic blood pressures into account separately revealed that systolic blood pressure was not associated with serum cholesterol independently from diastolic blood pressure, whereas diastolic blood pressure was associated with serum cholesterol independently of systolic blood pressure.

Table 3

Serum cholesterol in categories of blood pressure.

	Normal	Pre-hypertension	Stage 1 hypertension	Stage 2 hypertension
All subjects				
N	6661	34863	14327	933
Cholesterol (mmol/l)	4.0 ± 0.7	4.1 ± 0.7	4.2 ± 0.8	4.5 ± 0.9
Cholesterol >5.2 mmol/l (%)	5.3	6.3	8.6	15.6
Cholesterol >6.2 mmol/l (%)	0.6	0.8	1.3	2.7

Discussion

From the current data it is concluded that the prevalence of excess body weight and of blood pressure in the hypertensive range is high among young Swiss men undergoing medical conscript examinations, and that excess body weight and blood pressure in the hypertensive range are

strongly associated with each other and with high serum cholesterol in this population.

A trend of increasing body weight and obesity is an almost worldwide phenomenon. However, available data on the prevalence of obesity in adolescence or young adulthood shows considerable

Table 4

Results from linear regression analyses.

		Body mass index	Serum cholesterol	Systolic blood pressure	Diastolic blood pressure
Serum cholesterol	Model 1	0.27 [0.26–0.28]	n.a.	0.07 [0.06–0.07]	0.07 [0.07–0.08]
	Model 2	n.a.	n.a.	0.02 [0.01–0.03]	0.04 [0.03–0.05]
	Model 3	0.27 [0.26–0.27]	n.a.	–0.02 [–0.30]–[–0.01]	0.05 [0.04–0.06]
Systolic blood pressure	Model 1	0.17 [0.16–0.18]	0.07 [0.06–0.07]	n.a.	0.71 [0.70–0.72]
	Model 2	n.a.	0.02 [0.01–0.03]	n.a.	0.70 [0.69–0.71]
	Model 3	0.09 [0.08–0.09]	–0.01 [–0.02–0.00]	n.a.	0.70 [0.69–0.71]
Diastolic blood pressure	Model 1	0.13 [0.12–0.13]	0.07 [0.07–0.08]	0.71 [0.70–0.72]	n.a.
	Model 2	n.a.	0.04 [0.03–0.05]	0.71 [0.70–0.71]	n.a.
	Model 3	0.00 [–0.01–0.00]	0.03 [0.02–0.03]	0.71 [0.70–0.71]	n.a.

Standardized beta-coefficients are given together with 95% confidence intervals. Model 1 is unadjusted. Model 2 adjusts for BMI. Model 3 includes three of the four variables BMI, serum cholesterol, systolic blood pressure and diastolic blood pressure as independent variables whereas the respective fourth of these variables serves as dependent variable in the regression models.

geographical variation between Europe and the United States, as well as throughout Europe, with the highest rates of obesity in the United States, followed by eastern and southern European countries [21–30]. For Switzerland, estimates of the prevalence of obesity in adolescence are available from 1993 [12, 31] and from 2003 [31] however these estimates were based on self-reported weight and height values. The 2003 report described a 15% prevalence of excess bodyweight and obesity in a combined study sample of 20 year old military recruits and subjects of that age from the general community. Our present analysis from the period 2004–2007 was based on measured body weight and height and found a higher prevalence of 20.9% for excess bodyweight and obesity. Of note, the prevalence of excess body weight and obesity in our study population was similar to that found in primary school children in Switzerland [32].

BMI in late adolescence is an important predictor of both premature CAD and stroke [13, 33]. This may in part be explained by the strong association of excess body weight with blood pressure that was observed in the current investigation.

Indeed, only a minority of the investigated men had a blood pressure that was normal according to JNC VII guidelines; almost two thirds had blood pressure in the pre-hypertension range. Data on the prevalence of abnormal blood pressure in young men are scarce. An investigation on military conscripts from Israel had found an extremely high prevalence of pre-hypertension in adolescents 16.5–19 years of age [34], in which 56.8% of male subjects were pre-hypertensive. As in the current investigation, the prevalence of pre-hypertension was significantly higher in obese or overweight subjects in the study from Israel.

Similar to the current data on the prevalence of excess body weight and obesity, our results on the prevalence of high blood pressure in Swiss conscripts call for action. Hypertension as well as pre-hypertension in adolescence predict hypertension in adults [35], and high blood pressure is a

crucial modifiable risk factor for cardiovascular disease. The association between blood pressure and the risk of cardiovascular morbidity and mortality is consistent and continuous [20].

Hypertension is associated with obesity not only in adults, but also in children and adolescents [36]. A recent study from Sweden found that hypertension in young adulthood (diagnosed during conscript examinations) is associated with an increased risk of receiving disability pension later in life [37]. Obesity may have independent associations with blood pressure, but the entities are also related through physical inactivity and nutrition, which emphasizes the need to reduce the risks conferred by obesity and hypertension through lifestyle interventions. Concordant with our data Aeberli et al. demonstrated an association between blood pressure and body weight in Swiss children and adolescents [38]. That investigation also points to a possible relationship of hypertension or obesity with nutritional factors. Of note, the association between BMI and blood pressure in our study was quite strong: systolic as well as diastolic blood pressure differed by almost 10% between the extreme groups of BMI, an effect size which is in the same order of magnitude as that obtained with current antihypertensive therapy [39].

High levels of serum cholesterol are a major risk factor for cardiovascular disease [40]. Serum cholesterol in our investigation was around 20% higher in obese subjects than in those with low or normal BMI. As a 1 mg/dl increase of LDL cholesterol confers more than a 1% increase in cardiovascular risk [41], this association between BMI and serum cholesterol is clinically relevant. A 2004 examination of Swiss army conscripts has shown that 9.1% of the young men had cholesterol values above the limit (5.2 mmol/l) which is judged as desirable by the National Cholesterol Education Programme's updated clinical guidelines [42], and 1.4% had significantly elevated serum cholesterol levels >6.2 mmol/l. The overall serum cholesterol levels were somewhat lower in the current investigation from the period 2004–2007; however, our data show that serum chole-

terol significantly increases with both increasing body weight and increasing blood pressure. Indeed among obese men, one in four had serum cholesterol >5.2 mmol/l. Excess body weight and high blood pressure were associated with each other and linear regression analyses revealed that the association between BMI and serum cholesterol was stronger than that between blood pressure and serum cholesterol. However, excess body weight and high blood pressure were associated with serum cholesterol independently from each other.

Important strengths of this study are that the data are from the database providing the most recent prevalence estimate of body weight and obesity, hypertension, and serum cholesterol in young males in Switzerland, and also the large number of subjects included in the analysis. As discussed above, the key results were statistically significant and quantitatively of a clinically important order of magnitude. Due to the large sample size even much smaller between-group differences would have been statistically significant. Some limitations should also be considered. Most importantly, data is only provided for young men, because conscription is not compulsory for women in Switzerland. Further, HDL cholesterol levels were not available. Total cholesterol was measured in random blood samples and not in fasting serum samples. However, this should not have biased the data, because serum levels of total cholesterol are not strongly influenced by prior food intake [43]. Further, as only a single-occasion blood pressure measurement was available, an overestimation of the prevalence of high blood pressure in our study is possible, even though our data are in agreement with a report on the pre-

valence of elevated blood pressure in young men from Israel [34]. However, the striking associations between blood pressure and BMI or serum cholesterol indicate that the blood pressure measurements obtained in our study are indeed relevant for the cardiovascular risk estimation of the studied population. Most importantly, also "white coat hypertension" is associated with target organ damage [44].

In conclusion, the study found that excess body weight and high blood pressure are highly prevalent and closely associated with each other as well as with serum cholesterol in young Swiss men. Risk stratification and targeted risk intervention in adolescents and young adults is mandatory. Though the incidence of clinical events of atherosclerotic disease is very low in this age group, atherosclerotic plaques typically develop at young age, and it is at young age where long-term prevention might prove most effective [42]. Indeed, in older adults increased BMI is already associated with a considerable amount of morbidity and disability [45]. Data from conscription health examinations could be a useful tool for public health monitoring and timely risk intervention.

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References

- James PT, Rigby N, Leach R. The obesity epidemic, metabolic syndrome and future prevention strategies. *Eur J Cardiovasc Prev Rehabil.* 2004;11:3-8.
- Graham I, Atar D, Borch-Johnsen K, et al. European guidelines on cardiovascular disease prevention in clinical practice: full text. Fourth Joint Task Force of the European Society of Cardiology and other societies on cardiovascular disease prevention in clinical practice (constituted by representatives of nine societies and by invited experts). *Eur J Cardiovasc Prev Rehabil.* 2007;14(Suppl 2):S1-113.
- Grau M, Subirana I, Elosua R, et al. Trends in cardiovascular risk factor prevalence (1995-2000-2005) in northeastern Spain. *Eur J Cardiovasc Prev Rehabil.* 2007;14:653-9.
- Kautiainen S, Rimpela A, Vikat A, Virtanen SM. Secular trends in overweight and obesity among Finnish adolescents in 1977-1999. *Int J Obes Relat Metab Disord.* 2002;26:544-52.
- Kiefer I, Kunze U, Mitsche N, Kunze M. Obesity in Austria: epidemiologic and social medicine aspects. *Acta Med Austriaca.* 1998;25:126-8.
- Kuczmarski RJ, Flegal KM, Campbell SM, Johnson CL. Increasing prevalence of overweight among US adults. The National Health and Nutrition Examination Surveys, 1960 to 1991. *JAMA.* 1994;272:205-11.
- Petersen S, Brulin C, Bergstrom E. Increasing prevalence of overweight in young schoolchildren in Umea, Sweden, from 1986 to 2001. *Acta Paediatr.* 2003;92:848-53.
- Rissanen A, Heliovaara M, Aromaa A. Overweight and anthropometric changes in adulthood: a prospective study of 17,000 Finns. *Int J Obes.* 1988;12:391-401.
- Seidell JC, Verschuren WM, Kromhout D. Prevalence and trends of obesity in The Netherlands 1987-1991. *Int J Obes Relat Metab Disord.* 1995;19:924-7.
- Sorensen TI, Price RA. Secular trends in body mass index among Danish young men. *Int J Obes.* 1990;14:411-9.
- Tremblay MS, Katzmarzyk PT, Willms JD. Temporal trends in overweight and obesity in Canada, 1981-1996. *Int J Obes Relat Metab Disord.* 2002;26:538-43.
- Eichholzer M, Luthy J, Gutzwiller F. Epidemiology of overweight in Switzerland: results of the Swiss National Health Survey 1992-93. *Schweiz Med Wochenschr.* 1999;129:353-61.
- Falkstedt D, Hemmingsson T, Rasmussen F, Lundberg I. Body mass index in late adolescence and its association with coronary heart disease and stroke in middle age among Swedish men. *Int J Obes (Lond).* 2007;31:777-83.
- Gordon-Larsen P, Adair LS, Nelson MC, Popkin BM. Five-year obesity incidence in the transition period between adolescence and adulthood: the National Longitudinal Study of Adolescent Health. *Am J Clin Nutr.* 2004;80:569-75.
- Power C, Lake JK, Cole TJ. Body mass index and height from childhood to adulthood in the 1958 British born cohort. *Am J Clin Nutr.* 1997;66:1094-101.

- 16 Whitaker RC, Wright JA, Pepe MS, Seidel KD, Dietz WH. Predicting obesity in young adulthood from childhood and parental obesity. *N Engl J Med*. 1997;337:869–73.
- 17 Chan LC, Ware RS, Kesting J, Marczak M, Good D, Shaw JT. Association between anthropometric measures of obesity and cardiovascular risk markers in a self-selected group of indigenous Australians. *Eur J Cardiovasc Prev Rehabil*. 2007;14:515–7.
- 18 Schleiffenbaum BE, Schaer DJ, Burki D, et al. Unexpected high prevalence of metabolic disorders and chronic disease among young male draftees – the Swiss Army XXI experience. *Swiss Med Wkly*. 2006;136:175–84.
- 19 Rapi S, Bazzini C, Tozzetti C, Sbolci V, Modesti PA. Point-of-care testing of cholesterol and triglycerides for epidemiologic studies: evaluation of the multicare-in system. *Transl Res*. 2009;153:71–6.
- 20 Chobanian AV, Bakris GL, Black HR, et al. Seventh report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure. *Hypertension*. 2003;42:1206–52.
- 21 Ogden CL, Carroll MD, Curtin LR, McDowell MA, Tabak CJ, Flegal KM. Prevalence of overweight and obesity in the United States, 1999–2004. *JAMA*. 2006;295:1549–55.
- 22 Hsu LL, Nevin RL, Tobler SK, Rubertone MV. Trends in overweight and obesity among 18-year-old applicants to the United States military, 1993–2006. *J Adolesc Health*. 2007;41:610–2.
- 23 Rennie KL, Jebb SA. Prevalence of obesity in Great Britain. *Obes Rev*. 2005;6:11–2.
- 24 do C, I, dos SO, Camolas J, et al. Prevalence of obesity in Portugal. *Obes Rev*. 2006;7:233–7.
- 25 Rasmussen F, Johansson M, Hansen HO. Trends in overweight and obesity among 18-year-old males in Sweden between 1971 and 1995. *Acta Paediatr*. 1999;88:431–7.
- 26 Papadimitriou A, Fytanidis G, Papadimitriou DT, Priftis KN, Nicolaidou P, Fretzayas A. Prevalence of overweight and obesity in young Greek men. *Obes Rev*. 2007.
- 27 Schober E, Rami B, Kirchengast S, Waldhor T, Sefranek R. Recent trend in overweight and obesity in male adolescents in Austria: a population-based study. *Eur J Pediatr*. 2007;166:709–14.
- 28 Esposito-Del Puente A, Contaldo F, De Filippo E, et al. High prevalence of overweight in a children population living in Naples (Italy). *Int J Obes Relat Metab Disord*. 1996;20:283–6.
- 29 Moreno LA, Sarria A, Fleta J, Rodriguez G, Bueno M. Trends in body mass index and overweight prevalence among children and adolescents in the region of Aragon (Spain) from 1985 to 1995. *Int J Obes Relat Metab Disord*. 2000;24:925–31.
- 30 Prebeg Z, Juresa V, Kujundzic M. Secular growth changes in Zagreb schoolchildren over four decades, 1951–91. *Ann Hum Biol*. 1995;22:99–110.
- 31 Mohler-Kuo M, Wydler H, Zellweger U, Gutzwiller F. Differences in health status and health behaviour among young Swiss adults between 1993 and 2003. *Swiss Med Wkly*. 2006;136:464–72.
- 32 Zimmermann MB, Gubeli C, Puntener C, Molinari L. Overweight and obesity in 6–12 year old children in Switzerland. *Swiss Med Wkly*. 2004;134:523–8.
- 33 Bibbins-Domingo K, Coxson P, Pletcher MJ, Lightwood J, Goldman L. Adolescent overweight and future adult coronary heart disease. *N Engl J Med*. 2007;357:2371–9.
- 34 Israeli E, Schochat T, Korzets Z, Tekes-Manova D, Bernheim J, Golan E. Prehypertension and obesity in adolescents: a population study. *Am J Hypertens*. 2006;19:708–12.
- 35 Israeli E, Korzets Z, Tekes-Manova D, et al. Blood-pressure categories in adolescence predict development of hypertension in accordance with the European guidelines. *Am J Hypertens*. 2007;20:705–9.
- 36 Rebelo D, Teixeira J, Marques-Vidal P, Oliveira JM. Obesity markers and blood pressure in a sample of Portuguese children and adolescents. *Eur J Cardiovasc Prev Rehabil*. 2008;15:73–7.
- 37 Kark M, Karnehed N, Rasmussen F. Blood pressure in young adulthood and later disability pension. A population-based study on 867 672 men from Sweden. *Blood Press*. 2007;1–5.
- 38 Aeberli I, Molinari L, Spinaz G, Lehmann R, Allemann D, Zimmermann MB. Dietary intakes of fat and antioxidant vitamins are predictors of subclinical inflammation in overweight Swiss children. *Am J Clin Nutr*. 2006;84:748–55.
- 39 Jamerson K, Weber MA, Bakris GL, et al. Benazepril plus amlodipine or hydrochlorothiazide for hypertension in high-risk patients. *N Engl J Med*. 2008;359:2417–28.
- 40 Catapano AL, Pedersen TR, De Backer G. Averting a pandemic health crisis in Europe by 2020: what physicians need to know regarding cholesterol management. *Eur J Cardiovasc Prev Rehabil*. 2007;14:340–5.
- 41 Assmann G, Cullen P, Schulte H. Simple scoring scheme for calculating the risk of acute coronary events based on the 10-year follow-up of the prospective cardiovascular Munster (PROCAM) study. *Circulation*. 2002;105:310–5.
- 42 Executive Summary of The Third Report of The National Cholesterol Education Program (NCEP) Expert Panel on Detection, Evaluation, And Treatment of High Blood Cholesterol In Adults (Adult Treatment Panel III). *JAMA*. 2001;285:2486–97.
- 43 Bachorik PS, Cloey TA, Finney CA, Lowry DR, Becker DM. Lipoprotein-cholesterol analysis during screening: accuracy and reliability. *Ann Intern Med*. 1991;114:741–7.
- 44 Ihm SH, Youn HJ, Park CS, et al. Target organ status in white-coat hypertensives. *Circ J*. 2009;73:100–5.
- 45 Peytremann-Bridevaux I, Santos-Eggimann B. Health correlates of overweight and obesity in adults aged 50 years and over: results from the Survey of Health, Ageing and Retirement in Europe (SHARE). Obesity and health in Europeans aged > or = 50 years. *Swiss Med Wkly*. 2008;138:261–6.