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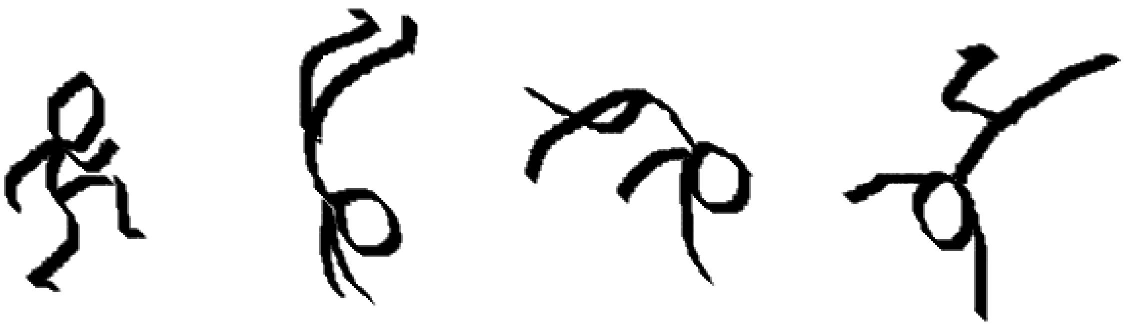
The combined effect of physical exercise and weight change on change in blood pressure: The HUNT study, Norway



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Abstract

Background: Both weight change and physical activity have been shown to be individual factors that affect blood pressure, but the combined effect of physical activity and weight change is still debated.

Objectives: To investigate the effects of physical activity and weight change on long term changes in both systolic-and diastolic blood pressure.

Design: A population- based longitudinal study, using baseline data from 1984-1986 and follow-up information in 1995-1997.

Setting: The Nord-Trøndelag Health Study (HUNT).

Subjects: We included 39 312 Norwegian subjects (18 727 men and 20 585 women) who were 20 year or older in the first survey, who were without blood pressure medication, diabetes, cardiovascular disease or movement dysfunction, and who had sufficient data on weight, height, physical activity, blood pressure or any other variable required in this analysis.

Measurements: Height, weight and blood pressure were measured using standardized procedures at both surveys. We classified weight change into the following categories; ≤-5.0, -4.9 to -2.1, ±2.0 (stable), 2.1-4.9, 5.0-9.9, 10.0-14.9, 15.0-19.9, and ≥20.0 kg. Physical activity was measured as frequency, intensity, and duration, and we also constructed a summary score by combining information on the three factors. Based on the summary score, we constructed a variable with five categories that reflects the total exercise volume: No activity, <1 exercise per week, low score, medium score, and high score.

Results: An increase in weight and a decrease in weight were significantly associated with increased and decrease in both systolic- and diastolic blood pressure in both sexes. Men with the highest decrease in weight, had a systolic blood pressure change that were 6.83 mmHg (95% CI, -8.01 to -5.66) lower than the reference group with stable weight, whereas men with the highest weight gain had a change that was 6.12 mmHg (95% CI, 4.09 to 8.15) higher. The corresponding data for women were 6.39 mmHg (95% CI,-7.53 to -5.26) lower, and 8.34 mmHg (95% CI, 6.79 to 9.90) higher than the reference group. No significant association between physical exercise and blood pressure was found. In the combined analysis weight change was the most pronounced factor, with little or no contribution from physical exercise.

Conclusion: Our results support the independent effect of weight change on change in systolic-and diastolic blood pressure. Weight change was the strongest predictor for change in blood pressure in the combined analyses, whereas little or no association between physical exercise and blood pressure were found.

Contents

Introduction

During the past century people in the western societies have adopted a more sedentary lifestyle. Factors such as more use of cars, more time spent in front of TV and, computer activities, and more inactive work situations have triggered a marked reduction in the amount of physical activity [1]. According to the World Health Organization [2], the recommended amount of physical activity [3] is only achieved by approximately 40% of the world`s population. Countries with a high rate of physical inactivity have also been showed to have a higher prevalence of overweight and obesity, compared with countries with a low prevalence of physical inactivity [4].

Obesity is considered one of the most serious public health challenges facing the world, due to its high prevalence and the number of diseases that can be linked to overweight and obesity [5]. Overweight and obesity is strongly associated with elevated blood pressure [6-11], another important public health challenge because of its high prevalence worldwide, expensive treatment, and strong link to cardiovascular diseases (CVD) [12,13].

According to Montani et al. [14], about 45% of deaths in the western world are related to CVD, mainly coronary heart disease, heart failure, stroke and renal failure, and another study reported non-blood pressure to be responsible for approximately half of all CVD [15]. Both excess weight and a non-optimal blood pressure are major factors for the predispose to CVD. Moreover, overweight has also shown to predisposal to hypertension [14], and long-duration obesity does not seem to be necessary to elevate blood pressure [16].

Globally, it has been estimated that 26.4% of the total adult population had hypertension in 2005, and this proportion is predicted to increase to about 60%, by 2025, reaching a total of 1.56 billion adults with hypertension [12]. Moreover, studies indicate that mortality and morbidity double for every 20 mmHg increase in systolic blood pressure above 115 mmHg and for every 10 mmHg increase in diastolic blood pressure above 75 mmHg [17,18]. However, studies have indicated that only small reductions in blood pressure, worldwide, may translate to a public health benefit. According to Cook et al. [19] a 2 mmHg decrease in diastolic blood pressure may result in a decrease in the prevalence of hypertension, coronary heart disease, and a reduction in the incidences of stroke and ischemic attacks, with 17%, 6%, and 15%, respectively. Another study reported that a 5 mmHg reduction in systolic blood pressure has been estimated to reduce mortality from coronary heart disease by 9%, stoke by 14%, and all causes by 7% [20].

Physical activity have been reported to have a positive effect on blood pressure [21-30] and it has been argued that physical activity can cancel out the negative effects of obesity, or that the risk of diseases associated with being overweight can be reduced in persons who are in good physical shape, even if they are overweight. Several studies have shown that physical activity can protect against the development of chronic disease and increase longevity [5, 31-36], and according to Blair et al. [37] are people with a low physical activity as likely to die from cancer and heart- and cardiovascular diseases, compared with moderately physically active individuals. This is also supported by another study who reported that individuals who are inactive and unfit have a 30 to 50% greater risk of getting high blood pressure, independent of change in body weight and percentage of body fat [27].

The aim of the present study was to investigate the independent and combined effects of physical activity and weight change on long term changes in blood pressure using longitudinal data from a large population-based study of Norwegian men and women.

Materials and method

Study population

Two large population- based health surveys have been conducted in the county of Nord-Trøndelag in Norway; HUNT 1 in 1984-1986 and HUNT 2 in 1995-1997. All citizens in the county aged 20 year or older were invited to participate at both surveys, and a total of 45 925 subjects (21 568 men and 24 357 women) participated in both HUNT 1 and HUNT 2. The participation rate were 88.1% (n=74 994) in the first survey and 71.2% (n=66 140) in the second survey. We excluded subjects with missing information on blood pressure, or subjects with a systolic blood pressure under 60 mmHg and/or a diastolic blood pressure under 30 mmHg in the first or second survey (n=55), as well as those who reported that they did or had used blood pressure medication (n=4113), had a middle or high movement dysfunction (n=1389), or reported cardiovascular disease (angina pectoris, stroke and myocardial infarction) or diabetes in the first survey (n=1038). Subjects with incomplete data on physical exercise, weight and height or any other variable required in this analyses (n=18) were also excluded. Thus, the present study comprised 18 727 men and 20 585 women (total n= 39312) aged 20 years or older (five people aged 17-19 were also included in our analysis). Information was collected from self-reported questionnaires and a standardized clinical examination and a personal identification number, which is unique for every Norwegian citizen, gave the opportunity to enable a linkage of data from the first to the second survey for each individual.

Physical exercise

For the purpose of the present study we used information on physical activity from the HUNT 1 questionnaire that was obtained from three questions about frequency, intensity and duration of exercise (appendix 1). The frequency question "how often do you exercise?" had five response options (0,<1,1,2-3,≥ 4 times per week; coded 1-5). Only those who reported a frequency of once a week or more answered the remaining questions on intensity and duration. The intensity question "How hard do you exercise?" had three response options (not sweat or out of breath/breathless, sweat and breathless, exhausted; coded 1-3). The duration question "For how long do you carry on each time?" had four response options (<15, 16-30, 30-60, >60 minutes; coded 1-4). Among those who reported a frequency of once a week or more, we constructed a summary score by combining information on frequency, duration and intensity. Each factor was given an equal weight by dividing each participant`s response (according to the variable coding) by the number of response options for the relevant variable.

Summary score = (frequency/5) + (intensity/3) + (duration/4)

This approach gave a maximum score of one for each of the three components, and a range of score values from 1.18 to 3.00. The participants were then categorized into three groups (thirds) based on the sex specific distribution of score values. Based on this, we constructed a variable with five categories that reflects the total exercise volume: No activity, <1 exercise per week, low score, medium score, and high score.

Because the question used in the present study specially ask about exercise, and not activity, we use the term physical exercise instead of physical activity when referring to our results in the following.

Standardized measurements (height, weight, and blood pressure)

Body mass

In both surveys weight was measured wearing light clothes without shoes to the nearest half kilogram, and height was measured without shoes to the nearest centimeter [38]. Body mass index (BMI) was calculated as bodyweight in kilograms divided by the squared value of body height in meters (kg/m^2). We calculated change in body weight between the surveys by subtracting the measured weight in HUNT 1 from the measurement in HUNT 2 for each individual, and then classified the participants into the following categories: ≤ -5.0, -4.9 to -2.1, ± 2.0 (stable), 2.1-4.9, 5.0-9.9, 10.0-14.9, 15.0-19.9, and ≥20.0 kg. In the analyses of the combined effect of weight change and physical exercise, some of the weight change categories were collapsed to maintain sufficient statistical power: >-2.1, ± 2.0 (stable), 2.1-8.0, 8.1-14.9, and ≥15.0 kg were used.

Moreover, based on their calculated BMI the participants were divided into groups according to WHO`s classifications [39]; underweight (<18.5 kg/m^2), normal weight (18.5 to 24.9 kg/m^2), overweight (25.0 to 29.9 kg/m^2), and obese (≥30.0 kg/m^2) in both HUNT 1 and HUNT 2. Based on this classification, we calculated the change in WHO category between the surveys and divided the participants into three groups; decreased (those who were in a lower BMI category in HUNT 2 than in HUNT 1), stable (those who were in the same BMI category), and increased (those who were in a higher category at HUNT 2 than in HUNT 1).

Blood pressure

At both surveys blood pressure were measured by trained nurses or technicians with the participants sitting with the arm resting on a table at heart level. Both systolic and diastolic blood pressure was read to the nearest 2 mmHg. At HUNT 1, blood pressure was measured twice on a sphygmomanometer after the participants had been seated for at least 4 minutes with the cuff placed on the right upper arm. At HUNT 2, blood pressure was measured three times, using a Dinamap 845XT based on oscillometry. The Dinamap was started after the participants had been seated for 2 minutes with the cuff on the arm [38]. In the present study we used the second measurement in HUNT 1 and the mean of the second and third measurement in HUNT 2. We then calculated the individual change in systolic and diastolic blood pressure between the surveys by subtracting the measurement in HUNT 1 from the measurement in HUNT 2.

In HUNT 1 a standard cuff of 15x55 cm was used for all participants, whereas in HUNT 2, the cuff size was based on the arm circumference, and was therefore in three different sizes; 12x37 cm (arm ≤ 24 cm), 15x50 cm (arm 25-35 cm), and 17x60 cm (arm ≥36 cm) [40].

Statistical analysis

We used a generalized linear model to estimate the adjusted mean change in systolic and diastolic blood pressure associated with categories of physical exercise, weight change, and change in BMI, and also with the combination of exercise and weight change, and exercise and change in BMI. We assessed the precision of the estimated mean differences by a 95% confidence interval (CI), and we tested for trends across categories of physical exercise, weight change, and body mass index, by treating these variables as ordinal variables in the regression model.

All analysis were adjusted for the potential confounding effect of age (continuous), smoking (never, former, current, and unknown) and education (<9 years, 10-12 years, >12 years, and unknown). In the analyses with weight change and BMI as an independent variable, we adjusted for the potential confounding effect of frequency of physical exercise (no exercise, <1, 1, 2-3, ≥4 times per week, or unknown). In the analyses of weight change and change in BMI we used those who had been stable between the surveys as the reference category (±2.0 kg or similar BMI category, respectively).

All analyses were conducted separately for men and women, and all statistical tests were two-sided. Moreover, all analyses were performed using SPSS for windows, version 15 (SPSS Inc., Chicago, Illinois, USA).

Ethics

The participation was completely voluntary and each participant signed a written consent. The second survey was approved by the Regional Ethical Committee for Medical Research. At the first survey the Regional Ethical Committee was not yet established.

Results

Descriptive statistics

We have studied 21 568 men (mean age 43.0) and 24 357 women (mean age 43.17) over a period of 11 years. At HUNT 1 41.1% (n= 7699) men were overweight and 5.6% (n=1050) were obese. Among women, the corresponding proportions were 27.0% (n=5565) overweight and 8.3% (n=1718) were obese. The mean weight change from HUNT 1 to HUNT 2 was 4.58 kg (SD, 6.09) for men and 5.29 kg (SD, 6.86) for women, whereas the mean change in systolic blood pressure was 7.92 mmHg (SD, 16.74) among men and 11.28 mmHg (SD, 17.68) among women. The mean change in diastolic blood pressure was 0.03 mmHg (SD, 11.19) and 0.39 mmHg (SD, 11.42), respectively. Some of the baseline characteristics are presented in Table 1. Based on the summary score, 9.0% (n= 1686) of men had no exercise, and 13.6% had high exercise. Among women, the corresponding proportions were 7.3% (n=1505) had no exercise, and 13.5% (n= 2788) had high exercise.

Table 1: Baseline characteristics

Variables	Men	Women
No. of participants	21 568	24 357
No. of cases excluded*	2841	3772
Age at study entry (years), mean (range)	43.0 (17-85)	43.17 (17-85)
Systolic blood pressure (mmHg), mean (SD) HUNT 1	133.17 (15.88)	126.37 (18.96)
Diastolic blood pressure (mmHg), mean (SD) HUNT 1	83.77 (10.10)	79.78 (10.62)
Height (cm), mean (SD) HUNT 1	177.31 (6.42)	164.16 (5.83)
Weight (kg), mean (SD) HUNT 1	78.58 (10.21)	65.18 (10.43)
Body mass index (kg/m2) mean (SD) HUNT 1	25.06 (2.92)	24.30 (3.85)
Education, percent >12 years (n)	11.4 % (2132)	8.5% (1757)
Smoking, percent current (n)	28.9 % (5413)	29.0% (5967)
Frequency of physical exercise, percent, ≥4 pr week (n)	8.1 % (1513)	9.0% (1854)

* Participants who used drug treatment for hypertension, who had a history of coronary heart disease, stroke or heart failure, subjects who had a disability who affected their physical activity level and subjects with incomplete data on physical exercise or any other variable required in analyses.

Weight change related to change in blood pressure

Overall, weight change showed a positive linear association with systolic blood pressure in both sexes (p-trend = <0.001 in both sexes) (Table 2). Men and women who had the highest weight loss (≤-5.0kg) had a mean adjusted systolic blood pressure change that was 6.83 mmHg (95% CI, -8.01 to -5.66) and 6.39 mmHg (95% CI, -7.53 to -5.26), respectively, lower than the reference group of people with a stable weight (±2.0kg). On the other hand, mean adjusted change in systolic blood pressure for men with the highest weight gain (≥20.0kg) was 6.12 mmHg (95% CI, 4.09 to 8.15), higher than those with a stable weight, and the corresponding difference among women was 8.34 mmHg (95% CI, 6.79 to 9.90). As showed in Table 2, adjusting for age, smoking, education, and frequency strengthened the associations compared to the crude results.

Table 2: Weight change related to change in systolic blood pressure

	Weight change	N	Mean change	Crude diff.	Adj. Diff[a]	95% CI	P-trend[b]
Men	≤ -5.0 kg	916	2.85	-4.74	-6.83	-8.01 to -5.66	
	-4.9 to -2.1 kg	1118	5.60	-1.98	-3.17	-4.25 to -2.09	
	±2.0 kg (stable)	4480	7.59	0.00	0.00	Reference	
	2.1 to 4.9 kg	3455	7.61	0.03	1.01	0.28 to 1.74	
	5.0 to 9.9 kg	5512	8.88	1.29	3.09	2.43 to 3.75	
	10.0 to 14.9 kg	2260	8.95	1.36	3.96	3.11 to 4.81	
	15.0 to 19.9 kg	713	10.40	2.81	6.01	4.69 to 7.33	
	≥ 20.0 kg	271	9.72	2.13	6.12	4.09 to 8.15	< 0.001
Women	≤ -5.0 kg	1142	5.61	-4.43	-6.39	-7.53 to-5.26	
	-4.9 to -2.1 kg	1015	10.05	0.01	-1.12	-2.30 to 0.06	
	±2.0 kg (stable)	4199	10.04	0.00	0.00	Reference	
	2.1 to 4.9 kg	3590	10.72	0.67	1.66	0.89 to 2.43	
	5.0 to 9.9 kg	6148	11.96	1.92	3.64	2.95 to 4.33	
	10.0 to 14.9 kg	2920	13.31	3.27	5.56	4.72 to 6.39	
	15.0 to 19.9 kg	1020	14.10	4.06	6.73	5.53 to 7.92	
	≥ 20.0 kg	550	15.21	5.17	8.34	6.79 to 9.90	< 0.001

Abbreviations: CI= Confidence Interval
[a] Adjusted for age (continuous), smoking (never, current, former, or unknown) and education (≤9, 10-12, >12 years, or unknown) and frequency (0,<1,1,2-3,≥ 4 times per week)
[b] P-value from linear trend test when exposure categories were treated as an ordinal variable in the generalized linear model.

The same positive linear association is also seen with diastolic blood pressure (Table 3). Men showed an adjusted change that was 3.73 mmHg (95% CI, -4.52 to -2.94) lower in the participants with the highest weight loss (≤5.0kg), and 5.01 mmHg (95% CI, 3.65 to 6.38) higher in the participants with the highest weight gain (≥20.0kg), compared to the reference group with stable weight (±2.0kg). Women showed the same trend, with an adjusted change that was 2.6 mmHg (95% CI, -3.34 to -1.86) lower in the highest weight loss group (>5.0kg), and 4.2 mmHg (95% CI, 3.18 to 5.21) higher in the highest weight gain group (≥20.0kg), compared to the reference group. These results, adjusted for the potential confounding effect of age, smoking, education, and frequency, where only marginally different from the crude results.

Table 3: Weight change related to change in diastolic blood pressure

	Weight change	N	Mean change	Crude diff.	Adj. Diff[a]	95% CI	P-trend[b]
Men	≤ -5.0 kg	916	-4.90	-3.48	-3.73	-4.52 to -2.94	
	-4.9 to -2.1 kg	1118	-2.76	-1.34	-1.50	-2.23 to -0.78	
	±2.0 kg (stable)	4480	-1.42	0.00	0.00	Reference	
	2.1 to 4.9 kg	3455	-0.14	1.29	1.39	0.90 to 1.88	
	5.0 to 9.9 kg	5512	1.28	2.70	2.85	2.41 to 3.30	
	10.0 to 14.9 kg	2260	2.11	3.53	3.68	3.11 to 4.26	
	15.0 to 19.9 kg	713	3.26	4.69	4.82	3.94 to 5.71	
	≥ 20.0 kg	271	3.37	4.79	5.01	3.65 to 6.38	<0.001
Women	≤ -5.0 kg	1142	-3.79	-2.88	-2.60	-3.34 to -1.86	
	-4.9 to -2.1 kg	1015	-1.28	-0.37	-0.19	-0.97 to 0.58	
	±2.0 kg (stable)	4199	-0.91	0.00	0.00	Reference	
	2.1 to 4.9 kg	3590	-0.04	0.87	0.73	0.22 to1.23	
	5.0 to 9.9 kg	6148	0.88	1.79	1.54	1.09 to 1.99	
	10.0 to 14.9 kg	2920	2.49	3.40	3.00	2.46 to 3.55	
	15.0 to 19.9 kg	1020	2.91	3.82	3.34	2.56 to 4.12	
	≥ 20.0 kg	550	3.84	4.76	4.20	3.18 to 5.21	<0.001

Abbreviations: CI= Confidence Interval

[a] Adjusted for age (continuous), smoking (never, current, former, or unknown) and education (≤9, 10-12, >12 years, or unknown) and frequency (0,<1,1,2-3,≥ 4 times per week)

[b] P-value from linear trend test when exposure categories were treated as an ordinal variable in the generalized linear model.

Body mass index related to change in blood pressure

Overall, there was a positive association between change in BMI category and change in systolic blood pressure (p-trend = <0.001) (Table 4). Men and women who decreased their BMI category had an adjusted change that was 4.83 mmHg (95% CI, -6.06 to -3.60) and 5.05 mmHg (95% CI, -6.27 to -3.83) lower than the reference group of people who did not change BMI category, respectively. On the other hand, men who increased their BMI category had a 2.7 mmHg (95% CI, 2.17 to 3.23) higher systolic blood pressure change than those with a stable BMI, and the corresponding difference among women was 4.22 mmHg (95% CI, 3.71 to 4.73).

A positive association was also seen with change in diastolic blood pressure. In men, those who decreased had an adjusted change that was 3.32 mmHg (95% CI, -4.14 to -2.49) lower than the reference group (stable), and the corresponding change among women was 2.48 (95% CI, -3.28 to -1.69) lower. On the other hand, men who increased their BMI had an adjusted change that was 2.33 mmHg (95% CI, 1.98 to 2.69) higher than the stable group, and the corresponding change among women was 2.37 mmHg (95% CI, 2.04 to 2.70) higher. Overall, adjustment for age, smoking, education, and frequency somewhat strengthened the differences is systolic blood pressure change compared to the crude estimates, whereas the effect of adjustment was smaller for diastolic blood pressure.

Table 4: Change in body mass index related to change in systolic- and diastolic blood pressure

		N	Mean change	Crude diff.	Adj. Diff[a]	95% CI	P-trend[b]
Men SBP	Decrease	746	4.79	-2.77	-4.83	-6.06 to -3.60	
	Stable	12248	7.56	0.00	0.00	Reference	
	Increase	5733	9.11	1.55	2.70	2.17 to 3.23	<0.001
Women SBP	Decrease	856	7.66	-2.54	-5.05	-6.27 to -3.83	
	Stable	12831	10.21	0.00	0.00	Reference	
	Increase	6898	13.75	3.54	4.22	3.71 to 4.73	<0.001
Men DBP	Decrease	746	-4.02	-3.45	-3.32	-4.14 to -2.49	
	Stable	12248	-0.57	0.00	0.00	Reference	
	Increase	5733	1.86	2.43	2.33	1.98 to 2.69	<0.001
Women DBP	Decrease	856	-3.48	-3.15	-2.48	-3.28 to -1.69	
	Stable	12831	-0.34	0.00	0.00	Reference	
	Increase	6898	2.24	2.58	2.37	2.04 to 2.70	<0.001

Abbreviations: CI= Confidence Interval. SBP= Systolic blood pressure. DBP= Diastolic blood pressure.
[a] Adjusted for age (continuous), smoking (never, current, former, or unknown) and education (≤9, 10-12, >12 years, or unknown) and frequency (0,<1,1,2-3,≥ 4 times per week)
[b] P-value from linear trend test when exposure categories were treated as an ordinal variable in the generalized linear model.

Physical exercise related to change in blood pressure

We examined the association between different aspects of physical exercise (frequency, intensity, duration and a summary score of all this factors) and change in systolic- and diastolic blood pressure.

Overall, there was no association between either components of physical exercise and systolic (Table 5) or diastolic (Table 6) blood pressure. However, the data could indicate that practically all groups that were physical active among men, had a lower change in systolic blood pressure compared with the reference group of people who reported no exercise. Among women, there were only the participants with the highest frequency and the highest intensity who had a lower change in systolic blood pressure, compared to the reference group. Men who reported the highest intensity of exercise had a systolic blood pressure change that was 1.41 lower than the reference group (95% CI, -2.98 to 0.15). The corresponding difference among women was 0.89 mmHg lower (95% CI, -3.61 to 1.83).

Table 5: Physical exercise and change in systolic blood pressure

	Physical exercise	N	Mean change	Crude diff.	Adj. Diff[a]	95% CI	P-trend[b]
Men							
Frequency	No exercise	1686	8.31	0.00	0.00	Reference	
	<1 per week	4990	7.62	-0.68	-0.29	-1.21 to 0.63	
	1 per week	4114	8.08	-0.23	-0.12	-1.07 to 0.83	
	2-3 per week	3581	7.61	-0.70	-0.28	-1.25 to 0.70	
	4+ per week	1513	8.22	-0.08	-0.85	-2.01 to 0.32	0.294
Intensity	No exercise	1686	8.31	0.00	0.00	Reference	
	Low	4109	9.07	0.76	-0.16	-1.12 to 0.81	
	Medium	6087	7.56	-0.75	-0.25	-1.18 to 0.68	
	High	648	4.79	-3.52	-1.41	-2.98 to 0.15	0.212
Duration	No exercise	1686	8.31	0.00	0.00	Reference	
	1-15 min	745	9.34	1.03	0.55	-0.89 to 2.00	
	16-30 min	2972	8.39	0.08	-0.09	-1.10 to 0.92	
	31-60 min	4632	7.77	-0.53	-0.36	-1.31 to 0.60	
	>60 min	2773	7.31	-1.00	-0.58	-1.61 to 0.45	0.119
Summary score	No exercise	1686	8.31	0.00	0.00	Reference	
	<1 pr week	4990	7.62	-0.68	-0.30	-1.22 to 0.62	
	Low	2576	8.43	0.12	-0.33	-1.36 to 0.69	
	Medium	3841	8.04	-0.27	-0.17	-1.13 to 0.79	
	High	2549	6.86	-1.45	-0.74	-1.78 to 0.29	0.302
Women							
Frequency	No exercise	1505	11.45	0.00	0.00	Reference	
	<1 pr week	5049	11.36	-0.09	0.92	-0.09 to 1.94	
	1 pr week	5071	11.26	-0.19	0.74	-0.27 to 1.76	
	2-3 pr week	3995	11.14	-0.31	0.34	-0.70 to 1.39	
	4+ pr week	1854	11.63	0.17	-0.46	-1.66 to 0.73	0.073
Intensity	No exercise	1505	11.45	0.00	0.00	Reference	
	Low	7339	12.21	0.76	0.55	-0.43 to 1.53	
	Medium	4769	10.47	-0.98	0.70	-0.35 to 1.74	
	High	183	7.74	-3.71	-0.89	-3.61 to 1.83	0.428
Duration	No exercise	1505	11.45	0.00	0.00	Reference	
	1-15 min	1098	12.46	1.01	0.68	-0.69 to 2.05	
	16-30 min	4516	11.53	0.75	0.56	-0.47 to 1.59	
	31-60 min	5593	11.13	-0.33	0.54	-0.47 to 1.55	
	>60 min	1244	11.63	0.18	0.94	-0.38 to 2.27	0.274
Summary score	No exercise	1505	11.45	0.00	0.00	Reference	
	<1 pr week	5049	11.36	-0.09	0.92	-0.08 to 1.93	
	Low	2590	11.87	0.42	0.37	-0.73 to 1.47	
	Medium	5061	11.31	-0.15	0.65	-0.35 to 1.66	
	High	2788	10.67	-0.78	0.17	-0.93 to 1.27	0.512

Abbreviations: CI= Confidence Interval.
[a] Adjusted for age (continuous), smoking (never, current, former, or unknown) and education (≤9, 10-12, >12 years, or unknown).
[b] P-value from linear trend test when exposure categories were treated as an ordinal variable in the generalized linear model.

Table 6: Physical exercise and change in diastolic blood pressure

	Physical exercise	N	Mean change	Crude diff.	Adj. Diff[a]	95% CI	P-trend[b]
Men							
Frequency	No exercise	1686	0.07	0.00	0.00	Reference	
	<1 per week	4990	-0.11	-0.18	-0.13	-0.75 to 0.49	
	1 per week	4114	0.02	-0.04	0.22	-0.42 to 0.86	
	2-3 per week	3581	0.14	0.07	0.45	-0.21 to 1.11	
	4+ per week	1513	-0.16	-0.66	-0.04	-0.83 to 0.75	0.167
Intensity	No exercise	1686	0.07	0.00	0.00	Reference	
	Low	4109	-0.35	-0.41	-0.04	-0.68 to 0.61	
	Medium	6087	0.05	-0.01	0.20	-0.42 to 0.82	
	High	648	-0.00	-0.07	-0.07	-1.12 to 0.97	0.545
Duration	No exercise	1686	0.07	0.00	0.00	Reference	
	1-15 min	745	-0.13	-0.20	0.06	-0.91 to 1.04	
	16-30 min	2972	-0.17	-0.23	0.01	-0.67 to 0.69	
	31-60 min	4632	0.04	-0.02	0.25	-0.39 to 0.89	
	>60 min	2773	-0.16	-0.23	0.02	-0.66 to 0.71	0.714
Summary score	No exercise	1686	0.07	0.00	0.00	Reference	
	<1 pr week	4990	-0.12	-0.18	-0.14	-0.76 to 0.48	
	Low	2576	-0.21	-0.28	0.08	-0.61 to 0.78	
	Medium	3841	0.09	0.03	0.40	-0.25 to 1.05	
	High	2549	-0.19	-0.25	0.07	-0.63 to 0.77	0.177
Women							
Frequency	No exercise	1505	0.15	0.00	0.00	Reference	
	<1 pr week	5049	0.50	0.35	0.05	-0.61 to 0.71	
	1 pr week	5071	0.31	0.16	0.01	-0.65 to 0.67	
	2-3 pr week	3995	0.33	0.17	0.21	-0.47 to 0.89	
	4+ pr week	1854	0.37	-0.52	-0.07	-0.85 to 0.70	0.841
Intensity	No exercise	1505	0.15	0.00	0.00	Reference	
	Low	7339	-0.09	-0.25	-0.01	-0.65 to 0.63	
	Medium	4769	0.68	0.52	0.24	-0.44 to 0.92	
	High	183	0.84	0.69	-0.03	-1.80 to 1.74	0.376
Duration	No exercise	1505	0.15	0.00	0.00	Reference	
	1-15 min	1098	-0.61	-0.77	-0.58	-1.47 to 0.30	
	16-30 min	4516	0.23	0.07	0.09	-0.58 to 0.75	
	31-60 min	5593	0.33	0.17	0.14	-0.52 to 0.79	
	>60 min	1244	0.87	0.71	0.73	-0.13 to 1.59	0.058
Summary score	No exercise	1505	0.15	0.00	0.00	Reference	
	<1 pr week	5049	0.50	0.35	0.05	-0.60 to 0.71	
	Low	2590	-0.29	-0.44	-0.26	-0.98 to 0.46	
	Medium	5061	0.39	0.23	0.18	-0.48 to 0.84	
	High	2788	0.39	0.24	0.18	-0.53 to 0.90	0.422

Abbreviations: CI= Confidence Interval.
[a] Adjusted for age (continuous), smoking (never, current, former, or unknown) and education (≤9, 10-12, >12 years, or unknown).
[b] P-value from linear trend test when exposure categories were treated as an ordinal variable in the generalized linear model.

The combined effect of weight change and physical exercise on change in blood pressure

The effect of weight change was the most striking in this analysis (Table 7). In general, participants who reduced their weight had a lower adjusted change compared to the reference group of participants with a stable weight (±2.0kg) and with no exercise, whereas participants who gained weight had a higher adjusted change, irrespective of their exercise level. However, there are some inconsistencies; among women who gained 8.1 to 14.9 kg the data indicated an almost positive linear association between the different levels of physical exercise and the change in blood pressure, whereas, there is a evidence of an inverse association among those with the highest weight gain (≥15.0kg). Participants who reported no exercise had a change in systolic blood pressure that was 5.95 mmHg (95% CI, 2.42 to 9.48) higher than the reference group; whereas participants with the highest exercise had a change that was 8.23 mmHg (95% CI, 5.63 to 10.84) higher. A similar trend was seen for diastolic blood pressure.

In both sexes, participants who had a stable weight (±2.0kg) and who where physical active had a somewhat lower change in blood pressure, compared to the reference group. However, these differences were not statistically significant. Men with a stable weight (±2.0kg) and low exercise had a change in systolic blood pressure that was 0.94 mmHg (95% CI, -2.58 to 0.70) lower than the reference group, and men with high exercise had a change that was 1.39 mmHg (95% CI, -3.10 to 0.31) lower.

Table 7: The joint effect of weight change and physical exercise on change in blood pressure

	≤ -2.1 kg (95% CI)	±2.0 kg (Stable) (95% CI)	2.1 to 8.0 kg (95% CI)	8.1 to 14.9 kg (95%CI)	≥15.0 kg (95%CI)
Men SBP					
No exercise	-5.21 (-7.67 to -2.74)	Reference	0.67 (-0.97 to 2.32)	3.04 (0.84 to 5.24)	5.74 (2.53 to 8.95)
>1 per week	-5.75 (-7.53 to -3.97)	-2.28 (-3.74 to -0.82)	0.89 (-0.43 to 2.22)	2.76 (1.24 to 4.28)	4.16 (1.95 to 6.37)
Low	-6.95 (-9.03 to -4.86)	-0.94 (-2.58 to 0.70)	0.65 (-0.84 to 2.14)	1.71 (-0.25 to 3.66)	5.96 (2.67 to 9.24)
Medium	-5.18 (-7.14 to -3.22)	-1.12 (-2.65 to 0.41)	0.29 (-1.08 to 1.66)	3.13 (1.46 to 4.80)	3.18 (0.36 to 6.01)
High	-6.23 (-8.67 to -3.80)	-1.39 (-3.10 to 0.31)	-0.01 (-1.51 to 1.50)	1.43 (-0.39 to 3.24)	4.38 (1.41 to 7.35)
Women SBP					
No exercise	-4.38 (-6.81 to -1.94)	Reference	2.18 (0.42 to 3.93)	6.36 (4.14 to 8.59)	5.95 (2.42 to 9.48)
>1 per week	-1.20 (-3.07 to 0.66)	0.41 (-1.09 to 1.92)	2.67 (1.41 to 3.93)	5.16 (3.74 to 6.58)	6.72 (4.76 to 8.69)
Low	-3.81 (-5.86 to -1.76)	-0.66 (-2.41 to 1.08)	3.31 (1.86 to 4.77)	5.28 (3.41 to 7.16)	6.02 (3.10 to 8.93)
Medium	-4.82 (-6.75 to -2.88)	0.40 (-1.06 to 1.85)	2.83 (1.58 to 4.09)	4.74 (3.29 to 6.19)	7.37 (5.36 to 9.38)
High	-3.49 (-5.75 to -1.24)	0.05 (-1.65 to 1.75)	2.04 (0.61 to 3.47)	4.54 (2.76 to 6.32)	8.23 (5.63 to 10.84)
Men DBP					
No exercise	-3.56 (-5.22 to -1.90)	Reference	0.58 (-0.52 to 1.69)	1.81 (0.34 to 3.29)	4.94 (2.79 to 7.09)
>1 per week	-3.43 (-4.63 to -2.23)	-1.72 (-2.71 to -0.74)	0.68 (-0.21 to 1.57)	1.65 (0.62 to 2.67)	3.05 (1.57 to 4.54)
Low	-4.04 (-5.44 to -2.64)	-1.19 (-2.30 to -0.09)	0.82 (-0.18 to 1.82)	2.15 (0.83 to 3.46)	3.99 (1.78 to 6.19)
Medium	-3.42 (-4.74 to -2.11)	-1.08 (-2.11 to -0.05)	0.98 (0.06 to 1.90)	3.03 (1.90 to 4.15)	2.87 (0.97 to 4.77)
High	-4.09 (-5.73 to -2.46)	-1.14 (-2.28 to 0.01)	0.42 (-0.59 to 1.43)	2.71 (1.49 to 3.93)	3.37 (1.37 to 5.37)
Women DBP					
No exercise	-2.05 (-3.64 to 0.46)	Reference	0.42 (-0.73 to 1.56)	2.76 (1.32 to 4.21)	2.12 (-0.18 to 4.42)
>1 per week	-1.74 (-2.95 to -0.52)	-0.83 (-1.82 to 0.15)	0.57 (-0.25 to 1.40)	2.07 (1.14 to 2.99)	2.88 (1.60 to 4.16)
Low	-1.30 (-2.63 to 0.04)	-0.97 (-2.11 to 0.17)	0.36 (-0.59 to 1.30)	1.78 (0.56 to 3.01)	2.29 (0.39 to 4.19)
Medium	-2.36 (-3.62 to -1.10)	-0.36 (-1.30 to 0.59)	0.79 (-0.03 to 1.60)	2.07 (1.12 to 3.02)	3.03 (1.72 to 4.34)
High	-1.97 (-3.44 to -0.50)	-0.05 (-1.16 to 1.06)	0.61 (-0.32 to 1.54)	1.81 (0.64 to 2.97)	4.85 (3.15 to 6.55)

Abbreviations: CI= Confidence interval. SBP= Systolic blood pressure. DBP= Diastolic blood pressure
Adjusted for age (continuous), smoking (never, current, former, or unknown) and education (≤9, 10-12, >12 years, or unknown)

The combined effect of body mass index and physical exercise on change in blood pressure

The analyses of the combined effect of BMI and physical exercise display a somewhat similar pattern as the analyses of weight change and physical exercise. The largest differences in blood pressure change are brought about by BMI change, whereas the effect of physical exercise is small or non-existing (Table 8). All men and women with a decrease in BMI category had a lower adjusted change in systolic blood pressure, compared with the reference group of participants with a stable BMI and no exercise. On the other hand, all men and women who had increased their BMI category had a higher adjusted change than the reference group. The same trend was seen with diastolic blood pressure.

Men who increased their BMI category and who did not exercise had a systolic blood pressure change that was 3.40 mmHg (95% CI, 1.65 to 5.16) higher than the reference category of men with stable BMI and no exercise, whereas men with increased BMI category and high exercise had a change that was 1.70 mmHg (95% CI, 0.22 to 3.18) higher. On the other hand, men with decreased BMI category and no exercise had a systolic blood pressure change that was 4.29 mmHg (95% CI, -8.05 to -0.53) lower than the reference group, and men with a decreased BMI category and high exercise had a change that was 5.74 mmHg (95% CI, -9.32 to -2.16) lower. The results for women were largely similar. This pattern was also observed for diastolic blood pressure, both in men and women.

Table 8: Systolic-and diastolic blood pressure and the combined effect of body mass index and physical exercise

		Decrease (95%CI)	Stable (95%CI)	Increase (95%CI)
Men SBP	No exercise	-4.29 (-8.05 to -0.53)	Reference	3.40 (1.65 to 5.16)
	>1 per week	-5.31 (-7.80 to -2.81)	-0.07 (-1.19 to 1.05)	2.59 (1.32 to 3.87)
	Low	-5.09 (-8.05 to -2.14)	-0.21 (-1.45 to 1.03)	2.88 (1.30 to 4.45)
	Medium	-3.47 (-6.27 to -0.67)	0.08 (-1.09 to 1.26)	2.21 (0.85 to 3.57)
	High	-5.74 (-9.32 to -2.16)	-0.41 (-1.67 to 0.86)	1.70 (0.22 to 3.18)
Women SBP	No exercise	-4.98 (-8.39 to -1.56)	Reference	5.52 (3.59 to 7.46)
	>1 per week	-2.58 (-5.28 to 0.12)	1.16 (-0.10 to 2.41)	4.84 (3.48 to 6.19)
	Low	-4.85 (-7.89 to -1.80)	0.69 (-0.69 to 2.07)	4.55 (2.94 to 6.16)
	Medium	-5.98 (-8.83 to -3.13)	0.92 (-0.34 to 2.17)	4.67 (3.30 to 6.03)
	High	-3.53 (-7.07 to 0.02)	0.16 (-1.20 to 1.52)	4.86 (3.27 to 6.44)
Men DBP	No exercise	-2.44 (-4.98 to 0.10)	Reference	2.45 (1.27 to 3.64)
	>1 per week	-3.31 (-5.00 to -1.63)	0.01 (-0.74 to 0.77)	2.04 (1.18 to 2.90)
	Low	-3.46 (-5.46 to -1.46)	0.07 (-0.76 to 0.91)	2.77 (1.70 to 3.83)
	Medium	-2.36 (-4.25 to -0.47)	0.50 (-0.29 to 1.29)	2.44 (1.52 to 3.36)
	High	-4.10 (-6.52 to -1.68)	-0.03 (-0.88 to 0.83)	2.62 (1.62 to 3.63)
Women DBP	No exercise	-2.71 (-4.94 to -0.47)	Reference	2.45 (1.18 to 3.71)
	>1 per week	-2.87 (-4.64 to -1.10)	-0.13 (-0.95 to 0.69)	2.32 (1.44 to 3.21)
	Low	-2.17 (-4.16 to -0.18)	-0.12 (-1.02 to 0.78)	1.41 (0.36 to 2.46)
	Medium	-2.04 (-3.91 to -0.18)	-0.01 (-0.83 to 0.81)	2.35 (1.46 to 3.24)
	High	-2.35 (-4.67 to -0.03)	0.10 (-0.79 to 0.99)	2.42 (1.38 to 3.45)

Abbreviations: CI= Confidence Interval. SBP= Systolic blood pressure. DBP= Diastolic blood pressure. Adjusted for age (continuous), smoking (never, current, former, or unknown) and education (≤9, 10-12, >12 years, or unknown) and frequency (0,<1,1,2-3,≥ 4 times per week)

Discussion

We analyzed both the independent and the combined effect of physical exercise and weight change on blood pressure. We found weight change to be positively related to blood pressure change in both men and women. Further, we found little or no association between the different levels of physical exercise on blood pressure. Thus, in the analyses combining physical exercise and weight change we found that weight change was the most pronounced factor, with little or no contribution from physical exercise.

The association between weight change and change in blood pressure

One important consequence of weight change is its impact on blood pressure. Similar to the findings in the present study, excess weight gain has previously been associated with elevated blood pressure [11, 41], and also with an increased risk for hypertension [17,42]. According to Wofford et al. [43], excess weight accounts for as much as 65-75% of the risk for essential hypertension. On the other hand, weight loss has been shown to lower blood pressure in several studies [41,44,45] and even a modest weight loss can lead to a long time reduction in blood pressure [46]. Several studies found that the changes in blood pressure according to weight change were independent of starting weight, or baseline BMI, both among men and women [10,40,47]. In line with these studies, we found changes in both BMI and weight to be positively related to change in among both men and women.

The exact underlying pathophysiological mechanisms of weight change on blood pressure are still not clear, and the pathogenesis of obesity related hypertension or elevated blood pressure is highly complex. There are several central and peripheral abnormalities that can explain the development or maintenance of high arterial pressure in obesity. Some of the factors are that weight gain stimulates sympathetic activation [6,43,48,49], which induces the blood pressure elevation regardless of blood pressure status or prior weight [48]. A long term activation of the sympathetic system could also raise arterial pressure by causing peripheral vasoconstriction and by increasing renal tubular sodium reabsorpion [49]. Weight change has also been shown to activate the rennin- angiotensin- alderstone system [43]. Further, obesity is also associated with renal function abnormalities and endothelial dysfunction that may play a role in the development of hypertension [49, 43]. Insulin and leptin are also probably involved [14,48].

The association between physical exercise and change in blood pressure

According to several studies, physical activity or physical fitness have been shown to protect against the development of chronic disease [35], reduce the risk of hypertension [24,25,34,50,51], reduce mortality [31-33], and reduce the risk of cardiovascular diseases [5].

In the present study physical exercise measured as frequency, intensity, duration, and with a summary score, showed little or no association between either components of physical exercise on blood pressure. Contrary to the findings in the present study, several previous studies have found an inverse relationship between physical activity and change in blood pressure. Studies have showed that aerobic exercise can lower both systolic and diastolic blood pressure [21- 30]. However, the amount of physical activity that has affected blood pressure varies. A study found that exercise could produce a 10 mmHg reduction in both systolic and diastolic blood pressure [24], other studies found more conservative estimations [21,22,30]. The different findings in the amount of physical activity on changes in blood pressure may be explained by different methods used to measure physical activity, such as questionnaires and fitness tests.

However, results from other studies are somewhat inconsistent, showing that training intensity and mode, frequency, and time per session, had no significant effect on blood pressure [26], that all aerobic training are effective in lowering blood pressure [24], and that low to moderate intensity training can be as beneficial as higher intensity training for reducing blood pressure [21,27-29].

Some pathophysiological mechanisms have been related to favorable effects of physical activity on blood pressure, and these are improved endothelial function [23], increased production of nitric oxide [52], beneficial adaptations in the cardiovascular system with regression of LVH, decreased arterial stiffness [23], reduction in sympathetic activity, improved vasodilatation, and increased arterial compliance [53]. In addition, increased physical activity may also favorably affect other factors as body weight, which again can influence blood pressure. However, the pathophysiological changes may only be partially reversible in obesity [54]

The combined effect of weight change and physical exercise on change in blood pressure

As mentioned above, both weight change [11,17,41,42,44,45] and physical activity [21-29] have been showed to have an individual effect on blood pressure. However, the hypothesis that physical activity can compensate for the adverse effect of overweight and obesity (weight gain) on blood pressure is still debated.

A lower risk of total mortality from cardiovascular diseases have been found in overweight and obese subjects who had a moderate to high level of cardiorespiratory fitness, compared with normal weight or overweight subjects with a low level of cardiorespiratory fitness [32,55]. This is also supported by Hu et al. [31] who found that physical activity decrease mortality both among obese and non-obese subjects. On the other hand, a study found that physical activity appeared to be beneficial at all levels of adiposity, but that adiposity predicted a higher risk of death regardless of the level of physical activity [33]. The risk of CHD associated with elevated BMI among women, have been found to be moderately reduced by increased physical activity levels [5,35]. The protective effect of physical activity on the risk of hypertension or elevated blood pressure is found in several studies, whereas two of three studies focused on cardiorespiratory fitness [25,34,51]. Vatten et al. [36] also reported that the risk for CVD associated with elevated blood pressure was higher in inactive subjects, compared to subjects who reported a higher activity level. However, in our analysis, the effect of weight change on change in blood pressure was the most striking, whereas the effect of physical exercise was small or non-existing. Thus, it seems uncertain whether physical activity can reduce the adverse effects of weight gain or adiposity, on blood pressure. Our findings show that the association between weight change and change in blood pressure is strong, and this association is not attenuated despite higher level of physical activity.

Strengths and limitation of the present study

The main strengths of the present study include the population-based nature of the data, the large sample size, the longitudinal design, and the long follow-up period. The high number of unselected participants, both men and women, reduces the possibility that chance findings and selection bias affect our results. The data collected in Nord-Trøndelag County is representative to the rest of Norway [38] and the personal identification number is enabling a linkage between individual data from both surveys. Further strengths are the wide age-range, and information on a large number of potential confounders. However, residual confounding due to unmeasured factors, such as diet cannot be ruled out. The use of standardized measurements of body weight and body height also strengthen the study, since several studies have found that overweight individuals are more likely to underestimate their self-reported weight and in general, people tend to overestimate their height [56].

On the other hand, there are some important limitations that should be considered when interpreting the results. In HUNT 1, 74 994 individual participated, but only 45 925 participated in both surveys (of whom 39312 were included in the present study). Some of those who did not participate at both surveys had died between HUNT 1 and HUNT 2. Moreover, among those who could participate in HUNT 2, 30% chose not to do so. At HUNT 1, it was shown that non-participants were somewhat older and sicker than those who participated [57]. It is conceivable that weight change, physical activity and blood pressure change could be related to the reason for non-participation, and that results would be different without this loss to follow up.

Further, self reported information on physical activity, will to some extent be inaccurate. However, the questionnaire used in the present study has been validated by Kurtze et al. [58] and found to be reproducible and provide useful measure of leisure-time physical activity. The use of self- reported physical activity also has no impact on the participants` activity level, and several studies have documented that self-reported physical activity is a strong predictor for sickness and death [59,60] The use of a large number of subjects is also shown to reduce problems resulting from imprecise classification, and allows demonstration of activity related benefits of enhanced health, reduced mortality and morbidity [61]. Further, the lack of an effect of physical activity in our study could, at least in part, be due to the single measure physical activity that was used, that does not capture the change in behavior that participants may have over time. However, a study has shown that the activity level is relatively stable in adulthood until the end of the sixties [1]. Moreover, cardiorespiratory fitness has also been shown to be a stronger predictor of several health outcomes than self-reported physical activity, probably since fitness is less prone to misclassification and also because other factors than activity may influence both health and fitness trough related biological factors [62].

Another potential source of bias is related to the blood pressure measurements; they were not conducted similarly in both surveys. Blood pressure measured with the Dinamap device is shown to be slightly lower than those measured with a sphygmomanometer [63]. Both the different measurements, the use of different cuff sizes and the time with the cuff on the arm, may introduce some bias to our results. However, this bias is likely to be non differential between the exercise groups, and may thus have underestimated our results. However, the use of one size cuff in HUNT 1 could give an incorrect blood pressure reading if the cuff is too small, and this could potentially underestimate the level of blood pressure change, especially among those with the highest arm circumference.

Further, BMI should be considered as a rough measure of body fat. It does not provide information on body fat distribution and may thus not correspond to the same degree of fatness in different individual [64]. However, BMI is easy to measure and is commonly used in classifying overweight and obesity in adult population and individuals. BMI provides the most useful population-level measure of overweight and obesity as it is the same for both sexes and for all ages of adults [39]. Previous studies have shown that waist circumference displays a stronger association with cardiovascular outcomes and risk factors, than BMI does [64-67]. However, waist circumference was not measured in the first survey, and hence we were not able to evaluate the association between change in waist circumference and blood pressure.

Conclusion

Our results support a causal association between weight change and change in blood pressure, among both men and women. Little or no association between either components of physical exercise and change in blood pressure was found. The effect of weight change was the most striking in our combined analysis. Participants who reduced their weight had a lower adjusted change in blood pressure compared with the reference group, whereas participants who increased their weight had a higher adjusted change in blood pressure, irrespective of their exercise level.

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Appendix

The questions regarding physical exercise

MOSJON

Med mosjon mener vi at du f.eks. går tur, går på ski, svømmer eller driver trening/idrett.

Hvor ofte driver du mosjon?
(Ta et gjennomsnitt)

Aldri	12	☐	1
Sjeldnere enn en gang i uka		☐	2
En gang i uka		☐	3
2–3 ganger i uka		☐	4
Omtrent hver dag		☐	5

Dersom du driver slik mosjon så ofte som en eller flere ganger i uka:
Hvor hardt mosjonerer du?
(Ta et gjennomsnitt)

Tar det rolig uten å bli andpusten eller svett	13	☐	1
Tar det så hardt at jeg blir andpusten og svett		☐	2
Tar meg nesten helt ut		☐	3

Hvor lenge holder du på hver gang?
(Ta et gjennomsnitt)

Mindre enn 15 minutter	14	☐	1
16–30 minutter		☐	2
30 minutter–1 time		☐	3
Mer enn 1 time		☐	4