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Nurse-led frequent educational meetings program effectiveness in significant weight loss in patients with coronary artery disease: A prospective study from Poland

Short title: Nurse-led education program is effective in reducing BMI in patients

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WHAT'S NEW?

We present a prospective uncontrolled interventional study that shows the impact of an educational program led by 200 nurses trained by cardiologists on body mass index (BMI) change in patients undergoing secondary prevention of cardiovascular disease. The presented program was efficient and improves the continuity and comprehensiveness of care for patients after acute coronary syndromes. The results of the study show that BMI decreased in the subgroups of men and women, smokers and non-smokers, in all subgroups of education levels, and in the subgroups of high stress and low physical activity. The strongest predictors of BMI's reduction were high education status and active smoking status. These novel findings will allow for further development and extension of the concept of the program and increase its effectiveness.

ABSTRACT

Background: Body mass index (BMI) reduction requires a multidimensional intervention in secondary prevention of cardiovascular disease.

Aims: To evaluate the effect of regular 1-year nursing supervision on weight reduction in secondary prevention after acute coronary syndrome.

Methods: The study was implemented from 2018 to 2022. 7612 patients were enrolled within 12 months after acute coronary syndrome, and regular nursing counseling was conducted every 2 months.

Results: 5% reduction in BMI was achieved by 6812 (89.75%) patients. BMI of the entire population decreased (27.47[0.08] vs. 27.19 [0.08]; P <0.001). BMI reduction was achieved in every subgroup of gender, smoking and International Standard Classification of Education (ISCED) as well as in the subgroup with the highest stress level 26.95(0.2) vs. 27.11 (0.06); P = 0.03, and the lowest physical activity level 27.63 (0.06) vs. 27.31 (0.06); P = 0.01. Linear regression showed that active smoking status (β –0.77; 95% confidence interval [CI], –0.95 to –0.59; P <0.001), ISCED 5–8 (β –0.43; 95% CI, –0.82 to –0.03; P = 0.03), ISCED 2 (β 0.79; 95% CI, 0.05–1.53; P = 0.04), ISCED 3 (β 0.55; 95% CI, 0.16–0.93; P = 0.01), triglycerides (β 0.78; 95% CI, 0.61–0.95; P <0.001) and waist-hip ratio (β 0.74; 95% CI, 0.68–0.80; P <0.001) were the strongest predictors of BMI change.

Conclusions: After 1 year of the study and 6 follow-up visits, the average BMI of the entire population decreased significantly. BMI decreased in the subgroups of men and women, smokers and non-smokers, in all subgroups of education levels, and in the subgroups of high stress and low physical activity. The strongest predictors of BMI's reduction were high education status and active smoking status.

Key words: acute coronary syndrome, body mass index, nursing counseling, public health management, secondary prevention

INTRODUCTION

Body mass index (BMI) categorizes adult weight issues and correlates with cardiovascular diseases, diabetes, and various cancers [1]. BMI is strongly associated with cardiovascular disease and type 2 diabetes like waist circumference [2]. Its limitations include neglecting adipose-muscle distinction, allowing over 30% body fat in seemingly normal-weight individuals [3]. Relative fat mass estimates body fat in those with normal weight, correlating low BMI with high body fat percentage and increased mortality [4]. Obesity's incidence is rising, with estimations of 51% American adults being obese by 2030, while 59% European adults and nearly 1/3 of children have above-normal BMI [5–8]. Weight reduction crucially mitigates cardiovascular mortality, prompting national obesity programs [9–12]. Many long-term nurse-led programs were based on consultations, physical activity education, and coaching over the phone, but their effectiveness varied, with 33% proving effective in reducing BMI or facilitating weight loss [13]. Studies covering the Polish population suggest a steadily increasing prevalence of obesity, so programs targeting weight reduction may become increasingly important [14]. The main goal was to implement such a program based on their own assumptions with considerable individualization of nursing recommendations tailored to patients' abilities. The rationale behind the presented program was to reduce the rate of subsequent acute coronary syndromes (ACS) episodes and mortality through a cost-effective nurse-led program with personalized care (Supplementary material, *Summary of Program*).

MATERIAL AND METHODS

Study design

This uncontrolled interventional study was carried out as part of the Regional Health Program (RHP) implemented by the Self-Government of the Świętokrzyskie Voivodship in Poland "Comprehensive cardiac rehabilitation as part of secondary prevention of working-age inhabitants of the Świętokrzyskie Voivodship after acute coronary syndromes" (project no. RPSW.08.02.01-26-0001/18) co-financed by the European Social Fund, coordinated by the "Uzdrowisko Busko-Zdrój" S.A. Poland. The program was developed by the Department of Health Protection of the Marshal's Office of the Świętokrzyskie Voivodeship and adopted by Resolution No. 2837/17 of the Board of the Świętokrzyskie Voivodeship on July 19, 2017, after prior approval by the Agency for Health Technology Assessment and Tarification. Due to the voluntary character of this government initiated project the Ethics Committee approval was waived.

Enrollment of participants

Patients provided signed informed consent to participate in the health program and could withdraw at any moment. The project was intended to cover as many as 7500 patients from the Świętokrzyskie Voivodship (approx. 1.2 million inhabitants). The inclusion criteria were: age >18 years, signed informed consent, previously diagnozed coronary artery disease, and compliance for frequent on-site meetings with a dedicated nurse. Exclusion criteria were inability to participate in follow up on -site meetings and terminal illness with life expectancy of <12 months. Patients were recruited by 200 nurses in hospital or ambulatory setting according to strictly defined criteria of RHP implemented in 2018–2022. All patients were enrolled in the study within 12 months of an ACS, after completing an educational and rehabilitation cycle funded by the National Health Service.

Nursing care organization

Participation was offered to consecutive patients who qualified for the program (met inclusion and none of the exclusion criteria described above). Then, each nurse provided support to 38 patients for 1 year according to an adopted schedule, which included: 1) educational activities that allowed patients to be monitored for 12 months through monthly phone calls and follow-up visits every 2 months; 2) educational meetings with a health educator (7 group meetings × 3 hours × 200 educators = 200 groups). There were 200 nurses recruited for the needs of the program and trained by cardiologists during 2 on-site conferences and seminars. Eligibility criteria to become a study nurse were: at least a bachelor’s degree in nursing and 1 year of work experience, access to patients with established cardiovascular disease. Case report form paper documents were filled in and collected by nurses and transferred to the study coordinator after completion of all follow-ups. Oral education by the dedicated nurse was performed providing advice on healthy lifestyle (diet, exercise. smoking cessation, weight loss, adherence to doctor's recommendations and prescribed medications). This regional health program focused on personalized intervention, including individually tailored physical activity, changes in eating habits (but tailored to the patient’s preferences as well as his or her abilities), and family support (the patient’s family was also informed of the program’s goals).

Analyzed variables

Parameters assessed in the study were measured on inclusion of the patient to the program and during elective on-site visits with the dedicated nurse according to best clinical practice (e.g. blood pressure and weight). Physical activity was defined as the duration of aerobic physical activity, and the amount was determined in minutes per week. Systolic and diastolic blood pressures were measured with a semiautomatic arm sphygmomanometer during the first meeting with the nurse. Low-density lipoprotein (LDL) cholesterol, glycemia, triglycerides were obtained from a fasting venous blood sample taken during the first appointment with the nurse. Waist to hip ratio was defined as the ratio resulting from dividing the waist circumference by the hip circumference, and measurements were taken at the first meeting with the nurse. The level of education was assessed according to the International Standard Classification of Education (ISCED). Levels indicate the following: 0 — pre-primary education; 1 — first stage of primary education; 2 — secondary (lower level) or junior high school; 3 — high school (upper secondary); 4 — post-secondary; 5 - 8 — university and higher degrees. A detailed summary of the program is described in Supplementary material, *Summary of Program*.

Statistical analysis

Continuous variables were presented as mean with standard deviation or median with the interquartile range (IQR) for normally and not normally distributed variables, respectively as assessed by Shapiro–Wilk test. Nominal variables were presented as counts and percentages. Comparison of continuous variables between non-reduced BMI group and reduced BMI group was performed using t-test and Mann–Whitney U test for normally and not normally distributed variables, respectively. Nominal variables were compared using χ^2 test and Fisher exact test, when appropriate. Analysis of changes of BMI over time was performed using multivariable regression using mixed effect modeling with the patient as random effect to account for correlation of repeated measures over time. The final model was constructed incorporating all variables all clinically important variables, multicollinearity was assessed using Variance Inflation Factors. Results from multivariable model were presented as coefficients (β) with two-sided 95% confidence intervals (CI), representing an increase in BMI per change in covariate. Bootstrap model validation was performed to evaluate model stability. Model marginal means were calculated to show values of BMI at different timepoints as well as for different levels of covariates. Results were presented as estimated BMI with standard error (SE). *P*-values for comparisons between different levels of model covariates were adjusted using Tukey HSD. Age, physical activity, stress level, systolic and diastolic blood pressure LDL, fasting glycemia, triglycerides and waist-to-hip ratio were included in the model as continuous. In addition estimated from the model changes in BMI over time were presented on plots with two-sided 95% CIs for values at specific follow-up with locally estimated scatterplot smoothing. Only available data were used, no missing data imputation was performed. For final BMI as well as for assessing the reduction of BMI last available observation was used. *P*-values are not adjusted for multiple comparisons as the analysis is exploratory in nature. Analyses were performed in R version 4.2.3 with packages ‘lme4’ version 1.1-33 and ‘emmeans’ version 1.8.6.

RESULTS

7590 patient has been enrolled in the study and 6812 (89.75%) patients achieved 5% reduction in BMI. During the entire study, mean BMI of the entire population decreased significantly (27.47 [0.08 vs. 27.19 [0.08]; P <0.001) (Figure 1). The population of the study and the reporting of follow-up visits are shown in Figure 2. The group with reduced BMI compared to group with stable BMI had higher initial BMIs and lower final BMIs in terms of BMI ≥18.5 kg/m^2, undertook physical exercise of shorter duration, was exposed to higher levels of stress, had higher systolic and diastolic blood pressure, higher LDL cholesterol and triglycerides plasma concentration, had higher fasting blood glucose and waist-hip ratio (Table 1). The subgroup analysis found significant reductions in BMI in both women and men, smokers and non-smokers, and in all subgroups of educational attainment. In the subgroups depending on the degree of stress severity, only the group with the highest stress levels (7–10 points) significantly reduced the BMI. In the subgroups based on the level of physical activity, only the group with the lowest intensity (<150 minutes per week) achieved significant weight reduction. BMI changed significantly in each subgroup by BMI. No age subgroup achieved significant weight reduction (Table 2). The course of BMI change according to all subgroups is shown in Figure 3. Subgroup analysis excluding those with BMI <25 kg/m^2 showed a significant reduction in BMI in the same subgroups (Table 3).

In the <30 years subgroup, a 5% decrease in BMI was achieved by 154 (86.52%), in the 30–39 years subgroup 698 (88.58%), in the 40–49 years subgroup 1883 (90.44%), in the 50–59 years subgroup 2759 (89%), in the ≥60 years subgroup 1318 (90.03%) patients; P = 0.23. In the subgroup of women, a 5% decrease in BMI was achieved by 4238 (90.57%) participants, and among men 2574 (87.76%); P <0.001. In the subgroup of non-smokers, a 5% decrease in BMI was achieved by 4062 (90.19%) participants, and among smokers, 2720 (88.4%); P = 0.01. In the subgroup with low stress, a 5% decrease in BMI was achieved by 653 (88.6%), with moderate stress 1811 (90.23%), and with high stress 4348 (89.32%); P = 0.38. In the subgroup with low level of physical activity, a 5% decrease in BMI was achieved by 5044 (88.71%), with moderate level 1297 (91.51%), with high level 463 (93.54%); P <0.001. In the subgroup with ISCED 0–1 level, a 5% decrease in BMI was achieved by 411 (85.8%) of participants, with ISCED 2 level 116 (86.57%), with ISCED 3 level 2100 (88.57%), with ISCED 4 level 1997 (90.32%), and with ISCED 5–8 level 2188 (90.53%); P = 0.01. In the BMI <18.5 kg/m^2 subgroup, a 5% decrease in BMI was achieved by 7 patients (10.61%), in the 18.5–24.99 kg/m^2 subgroup, a 5% decrease in BMI was achieved by 762 patients (35.56%), in the 25–29.99 kg/m^2 subgroup, a 5% decrease in BMI was achieved by 1823 patients (52.6%), while in the ≥30 kg/m^2 subgroup, a 5% decrease was achieved by 1094 patients (57.13%), p<0.001. Factors affecting BMI reduction were subsequent follow-up appointments (III–VI), higher education (ISCED 5–8) and active smoking. Predictors of increasing BMI were age, systolic and diastolic blood pressure arterial pressure, fasting blood glucose, triglycerides and waist-hip ratio (Table 4). The distribution of patients according to BMI, age, and county-level residence are shown in Supplementary material, *Table S1*. The model with all analyzed factors that could affect BMI change is shown in Figure 4.

DISCUSSION

In the present study, regular nursing consultations achieved a significant reduction in mean BMI (27.47 [0.08] vs. 27.19 [0.08]; p<0.001), and a 5% reduction in BMI was achieved in up to 89.75% of the study population. Williamson et al. [15] demonstrated that a 5% reduction in body weight is sufficient to achieve clinically significant benefits. A weight loss of more than 10% may have an impact on mortality [16]. A system of nursing interventions to support weight reduction has already been implemented in numerous programs [17–19]. The 5 A's model is utilized in primary care to motivate patients to modify their behavior, thereby reducing cardiovascular risk [20]. Van Dillen et al. [21] observed that during such consultations, the topics of weight, nutrition, and physical activity are typically addressed. Patient clubs can significantly improve smoking cessation rates and increase physical activity among patients [22].

In the current study, BMI decreased significantly regardless of gender, smoking and education level. Subgroup analysis showed that among the subgroups of the three levels of physical activity, only the subgroup with the lowest level of exercise intensity experienced a decrease in BMI, and among the 3 subgroups on stress level, only the group with the highest level of stress achieved a reduction in BMI. Ross et al. [23] found that low activity levels and high stress levels were contributing factors to greater weight regain. Adrenaline secreted during acute stress suppresses appetite, whereas elevated levels of cortisol during chronic stress increase appetite [24, 25]. The AusDiab study found that psychosocial stress, defined as subjectively perceived stress, along with a history of at least 2 stressful life events, was associated with weight gain over 5 years [26]. Many studies have shown that physical activity, including diaphragmatic breathing, progressive muscle relaxation, guided visualization, and education on healthy nutrition and dietary habits, is associated with weight change [27–31]. In the present study, the subgroup with the lowest baseline exercise intensity achieved a significant reduction in BMI. Tijssen et al. [32] demonstrated in their study that intervention in a group with a BMI of ≥27 kg/m^2 and self-reported physical inactivity (≤150 minutes of moderate-intensity physical activity per week) was the most effective [32]. Gobbo et al. [33] proposed Nordic walking as an enjoyable physical activity that, when performed 4–5 times a week for 60 minutes each session, can reduce body weight, lower body fat, and improve glycemic control. The amount of weight reduction has been shown to be directly proportional to the increase in exercise volume and the transition from moderate to vigorous exercise [34]. This study demonstrated a significant reduction in BMI among both smokers and non-smokers; however, active smoking was identified as an independent predictor of BMI reduction. A large randomized cohort study of Copenhagen residents found that heavy smoking (more than 10 cigarettes per day) was associated with lower BMI, as well as reduced waist and hip circumference [35]. In a large cross-sectional study of the general UK population, Dare et al. [36] found that active smokers over 40 years of age are less likely to be obese. Additionally, the risk of obesity in former smokers increases in proportion to the number of cigarettes smoked. All education subgroups showed a reduction in BMI, but low ISCED 2, ISCED 3 were independent predictors of weight gain, and ISCED 5–8 was an independent predictor of weight reduction. Dilektasli et al. [37] demonstrated that low levels of education were associated with inadequate weight reduction (defined as less than 50% excess body weight loss) following bariatric surgery. In this study, higher education increased the likelihood of achieving more than 50% reduction in excess body weight by almost fourfold [37]. A large cross-sectional study from Taiwan found an increased risk of obesity in the elderly, particularly among women, with a shorter duration of education (12 years or less) compared to those with a longer duration (16 years or more) [38]. Furthermore, an inverse relationship was identified between education level and obesity in high-income countries, while a positive relationship was observed between education level and obesity in low-income countries [39].

The educational program conducted by trained nurses has demonstrated effectiveness in reducing a significant risk factor for cardiovascular disease. Another initiative, Coordinated Care in Myocardial Infarction (KOS-MI), showed a relative reduction in the risk of major adverse cardiac and cerebrovascular events, mortality, repeat revascularization, and hospitalization for heart failure, thereby reinforcing the importance of establishing programs for secondary prevention [40].

The main limitation of the study is the lack of a control group. All study participants were volunteers recruited by nurses in an inpatient or outpatient setting, which is also a major limitation. Another limitations are analysis including potential confounding variables (age, gender, stress level, and physical activity), lack of detailed data on the course of treatment of ACS patients and their clinical parameters, and lack of validation of the study group. The advantages of this study are the large sample size and the over 90% reporting rate for follow-up visits. The achieved reduction in BMI is significant despite the small change in this variable which may be due to the large size of the study population, the standardized effect of BMI reduction was not presented, which may be small.

CONCLUSIONS

After 1 year of the study and 6 follow-up visits, the average BMI of the entire population decreased significantly. BMI decreased in the subgroups of men and women, smokers and non-smokers, in all subgroups of education levels, and in the subgroups of high stress and low physical activity. A simple nurse-led educational program with frequent on-site meetings (every 2 months) for patients with established coronary artery disease resulted in significant improvement in one of the most important predictors of morbidity and mortality. Further studies are needed to determine the most effective methods to help patients reduce weight.

Supplementary material

Supplementary material is available at https://journals.viamedica.pl/polish_heart_journal.

Article information

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Table 1. Baseline characteristics

Variable		Non-reduced BMI group[a]	Reduced BMI group[a]	Total	*P*-value
Age, years		52 (45–58)	52 (45–58)	52 (45–58)	0.93
Male gender, n (%)		1503 (38.28)	1430 (38.80)	2933 (38.53)	0.65
Education, grades of ISCED, n (%)	ISCED 0	0 (0)	1 (0.03)	1 (0.01)	0.19
	ISCED 1	229 (5.83)	249 (6.76)	478 (6.28)	
	ISCED 2	77 (1.96)	57 (1.55)	134 (1.76)	
	ISCED 3	1201 (30.59)	1170 (31.74)	2371 (31.15)	
	ISCED 4	1163 (29.62)	1048 (28.43)	2211 (29.05)	
	ISCED 5-8	1256 (31.99)	1161 (31.50)	2417 (31.75)	
Active smoking status, n (%)		1573 (40.32)	1504 (40.87)	3077 (40.59)	0.63
Number of smoked cigarettes, n/24 h		15 (10-20)	15 (10–20)	15 (10–20)	0.88
Physical activity, min/week		100 (40-150)	90 (30–135)	90 (35–150)	0.01
Physical activity, n (%)	Low (<150 min/week)	2861 (72.93)	2825 (76.75)	5686 (74.78)	<0.001
	Medium (150–300 in/week)	797 (20.32)	626 (17.01)	1423 (18.71)	
	High (>300 min/week)	265 (6.76)	230 (6.25)	495 (6.51)	
Stress, 0–10 scale		7 (6–8)	8 (6–9)	7 (6–9)	<0.001
Stress level, n (%)	Low (0–4 points)	384 (9.78)	353 (9.58)	737 (9.68)	<0.001
	Medium (5–6 points)	1106 (28.17)	901 (24.44)	2007 (26.37)	
	High (7–10 points)	2436 (62.05)	2432 (65.98)	4868 (63.95)	
Systolic blood pressure, mm Hg		138 (130–142)	140 (130–150)	140 (130–145)	<0.001

Diastolic blood pressure, mm Hg		80 (80–90)	85 (80–90)	85 (80–90)	<0.001
LDL cholesterol, mg/dl		138 (115–185.8)	141 (118–190)	140 (115–190)	<0.001
Triglycerides, mg/dl		152.34 (128–77.49)	160 (135–182)	156 (130–180)	<0.001
Fasting glycemia, mg/dl		95 (86–100.95)	98 (90–104.4)	96 (88–103)	<0.001
Fasting glycemia, levels, n (%)	<70 mg/dl	43 (1.10)	19 (0.52)	62 (0.82)	<0.001
	70–99 mg/dl	2649 (67.65)	2148 (58.39)	4797 (63.16)	
	100–125 mg/dl	1042 (26.61)	1306 (35.50)	2348 (30.92)	
	≥ 126 mg/dl	182 (4.65)	206 (5.60)	388 (5.11)	
Waist-hip ratio index,		0.89 (0.8–1.0)	0.90 (0.81–1.0)	0.90 (0.80–1.0)	<0.001
Blood pressure (n, %)	Normal	1787 (45.52)	1307 (35.46)	3094 (40.65)	<0.001
	I degree AH	1018 (25.93)	1189 (32.26)	2207 (28.99)	
	II degree AH	275 (7)	362 (9.82)	637 (8.37)	
	III degree AH	44 (1.12)	65 (1.76)	109 (1.43)	
	Isolated systolic AH	802 (20.43)	763 (20.70)	1565 (20.56)	
BMI initial, kg/m^2	<18.5	17.50 (1.01)	18.04 (0.27)	17.56 (0.97)	0.18
	18.5–24.99	22.63 (1.58)	23.06 (1.52)	22.79 (1.57)	<0.001
	25–29.99	27.07 (1.45)	27.38 (1.41)	27.23 (1.44)	<0.001
	≥30	32.80 (3.09)	33.30 (3.21)	33.08 (3.17)	<0.001
BMI final, kg/m^2	<18.5	18.41 (1.97)	17.44 (1.04)	18.30 (1.91)	0.13
	18.5–24.99	23.09 (1.94)	22.55 (1.62)	22.89 (1.85)	<0.001
	25–29.99	27.28 (1.65)	26.52 (1.56)	26.87 (1.64)	<0.001
	≥30	33.06 (3.12)	31.99 (3.43)	32.43 (3.35)	<0.001

[a]Based on last available observation

Abbreviations: AH, arterial hypertension; BMI, body mass index; ISCED, International Standard Classification of Education; LDL, low-density lipoprotein; WHR, waist-hip ratio

Table 2. Changes of body mass index (BMI) values in specific subgroups (total population)

Groups		Initial BMI, [kg/m^2]	Final BMI, kg/m^2	*P*-value
Age, years	<30	25.19 (0.32)	25.02 (0.34)	0.99
	30–39	26.29 (0.15)	25.83 (0.16)	0.98
	40–49	27.16 (0.09)	26.87 (0.1)	0.98
	50–59	27.73 (0.08)	27.42 (0.08)	0.66
	≥60	27.91 (0.11)	27.63 (0.12)	0.99
Gender	Men	27.48 (0.1)	27.2 (0.1)	<0.001
	Women	27.47 (0.09)	27.18 (0.09)	<0.001

Current smoking	Yes	27.09 (0.1)	26.81 (0.1)	<0.001
	No	27.86 (0.09)	27.58 (0.09)	<0.001
Stress level	Low (0–4 points)	27.3 (0.16)	27.01 (0.16)	0.99
	Medium (5–6 points)	27.29 (0.1)	27.04 (0.1)	0.97
	High (7–10 points)	27.46 (0.06)	27.13 (0.06)	0.03
Physical activity level	Low (<150 min/week)	27.63 (0.06)	27.31 (0.06)	0.01
	Medium (150–300 min/week)	26.61 (0.1)	26.36 (0.12)	0.99
	High (>300 min/week)	26.95 (0.19)	26.81 (0.2)	0.99
Education grade	ISCED 0–1	27.36 (0.18)	27.08 (0.18)	<0.001
	ISCED 2	28.16 (0.33)	27.88 (0.33)	<0.001
	ISCED 3	27.91 (0.08)	27.63 (0.08)	<0.001
	ISCED 4	27.0 (0.09)	26.72 (0.08)	<0.001
	ISCED 5–8	26.94 (0.09)	26.65 (0.09)	<0.001
BMI	<18.5	17.56 (0.27)	18.34 (0.27)	<0.001
	18.5–24.99	22.79 (0.05)	22.89 (0.05)	<0.001
	25–29.99	27.23 (0.04)	26.87 (0.04)	<0.001
	≥30	33.08 (0.05)	32.38 (0.05)	<0.001

Data presented as marginal mean with standard error (SE) estimated from the model (for gender, current smoking and education level) or as estimated patient level BMI compared across groups (age, stress level and physical activity level) presented as mean with SE

Table 3. Changes of BMI values in specific subgroups (population with body mass index [BMI] >25)

Groups		Initial BMI, kg/m^2	Final BMI, kg/m^2	*P*-value
Age, years	<30	28.89 (0.4)	28.18 (0.41)	0.99
	30–39	28.95 (0.17)	28.28 (0.17)	0.62
	40–49	29.16 (0.1)	28.7 (0.1)	0.2
	50–59	29.44 (0.07)	28.96 (0.08)	0.33

	≥60	29.48 (0.11)	29.05 (0.11)	0.61
Gender	Men	29.9 (0.1)	28.85 (0.1)	<0.001
	Women	29.43 (0.09)	28.98 (0.09)	<0.001
Current smoking	Yes	29.02 (0.1)	28. (0.1)	<0.001
	No	29.71 (0.09)	29.26 (0.09)	<0.001
Stress level	Low (0–4 points)	29.23 (0.16)	28.72 (0.16)	0.79
	Medium (5–6 points)	29.4 (0.1)	28.94 (0.1)	0.1
	High (7–10 points)	29.3 (0.06)	28.82 (0.06)	<0.001
Physical activity level	Low (<150 min/week)	29.43 (0.06)	28.93 (0.06)	<0.001
	Medium (150–300 min/week)	28.97 (0.12)	28.55 (0.12)	0.67
	High (>300 min/week)	28.87 (0.19)	26.81 (0.19)	0.99
Education grade	ISCED 0–1	29.34 (0.18)	28.89 (0.18)	<0.001
	ISCED 2	29.99 (0.34)	29.54 (0.34)	<0.001
	ISCED 3	29.63 (0.08)	29.18 (0.08)	<0.001
	ISCED 4	28.94 (0.09)	28.49 (0.09)	<0.001
	ISCED 5–8	28.92(0.09)	28.47 (0.09)	<0.001

Data presented as marginal mean with standard error (SE) estimated from the model (for gender, current smoking and education level) or as estimated patient level BMI compared across groups (age, stress level and physical activity level) presented as mean with SE

Table 4. Independent predictors of body mass index (BMI) change

Variable	β (95% CI)	*P*-value
2 months	0.02 (0.002–0.03)	0.09
4 months	–0.01 (–0.03 to 0.01)	0.17
6 months	–0.08 (–0.10 to –0.06)	<0.001
8 months	–0.15 (–0.17 to –0.12)	<0.001
10 months	–0.22 (–0.25 to –0.20)	<0.001
12 months	–0.28 (–0.31 to –0.25)	<0.001

Gender (male)	0.02 (–0.18 to 0.21)	0.88
Initial age (per 10 years)	0.32 (0.22–0.42)	<0.001
Education (ISCED 2)	0.79 (0.05–1.53)	0.04
Education (ISCED 3)	0.55 (0.16–0.93)	0.01
Education (ISCED 4)	–0.36 (–0.75 to 0.02)	0.06
Education (ISCED 5-8)	–0.43 (–0.82 to –0.03)	0.03
Active smoking status	–0.77 (–0.95 to –0.59)	<0.001
Physical activity (100 min per week)	–0.02 (–0.06 to 0.01)	0.16
Stress level (10 points scale)	0.00 (–0.05 to 0.05)	0.97
Systolic blood pressure (per 10 mm Hg)	0.04 (0.03–0.05)	<0.001
Diastolic blood pressure (per 10 mm Hg)	0.03 (0.02–0.04)	<0.001
LDL cholesterol (per 100 mg/dl)	–0.15 (–0.34 to 0.04)	0.12
Fasting glycemia (per 100 mg/dl)	0.34 (0.30–0.39)	<0.001
Triglycerides (per 100 mg/dl)	0.78 (0.61–0.95)	<0.001
WHR (per 10)	0.74 (0.68–0.80)	<0.001

Model results presented as coefficient with two-sided 95% CI

Abbreviations: see Table 1

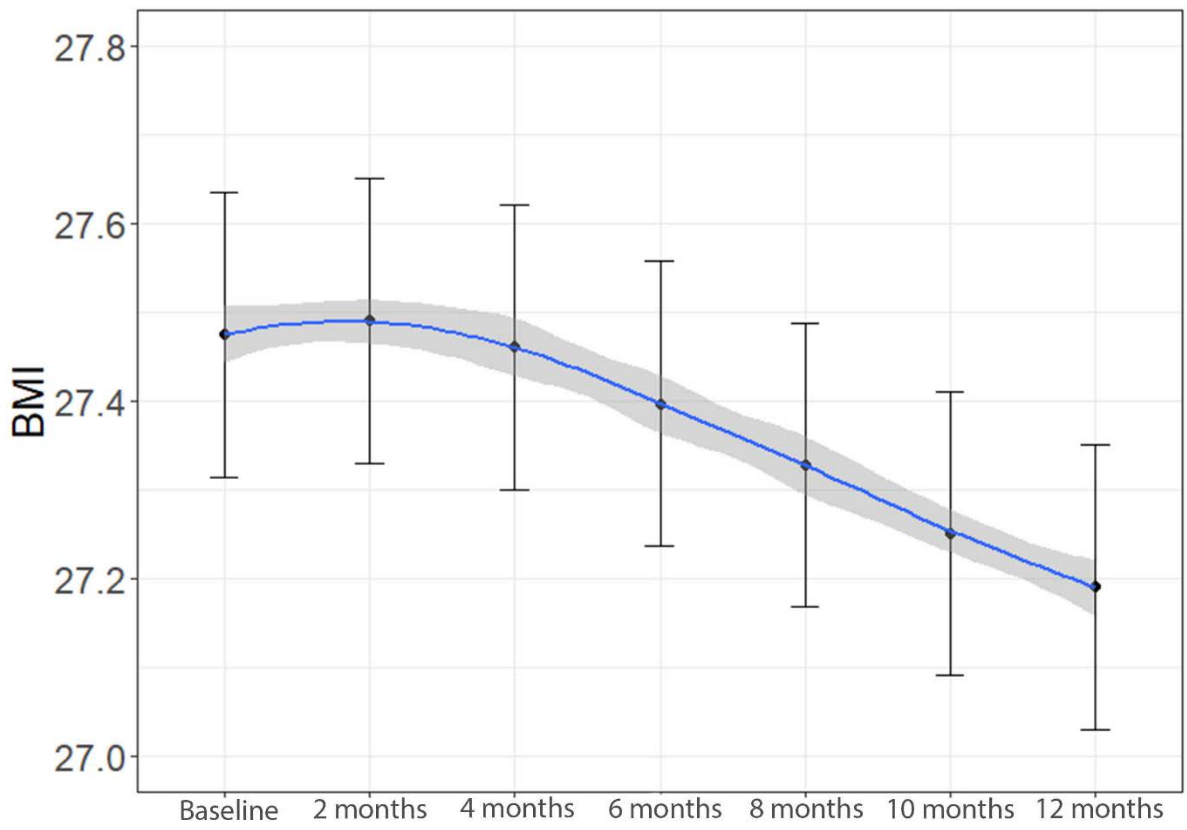

Figure 1. The body mass index (BMI, expressed in kg/m^2) reduction among entire study population during 12 months observation. Values presented as marginal means (points) with 2-sided 95% confidence interval (whiskers) as well as filled locally estimated scatterplot smoothing (curve) and 2-sided 95% confidence interval for the fit (shaded area)

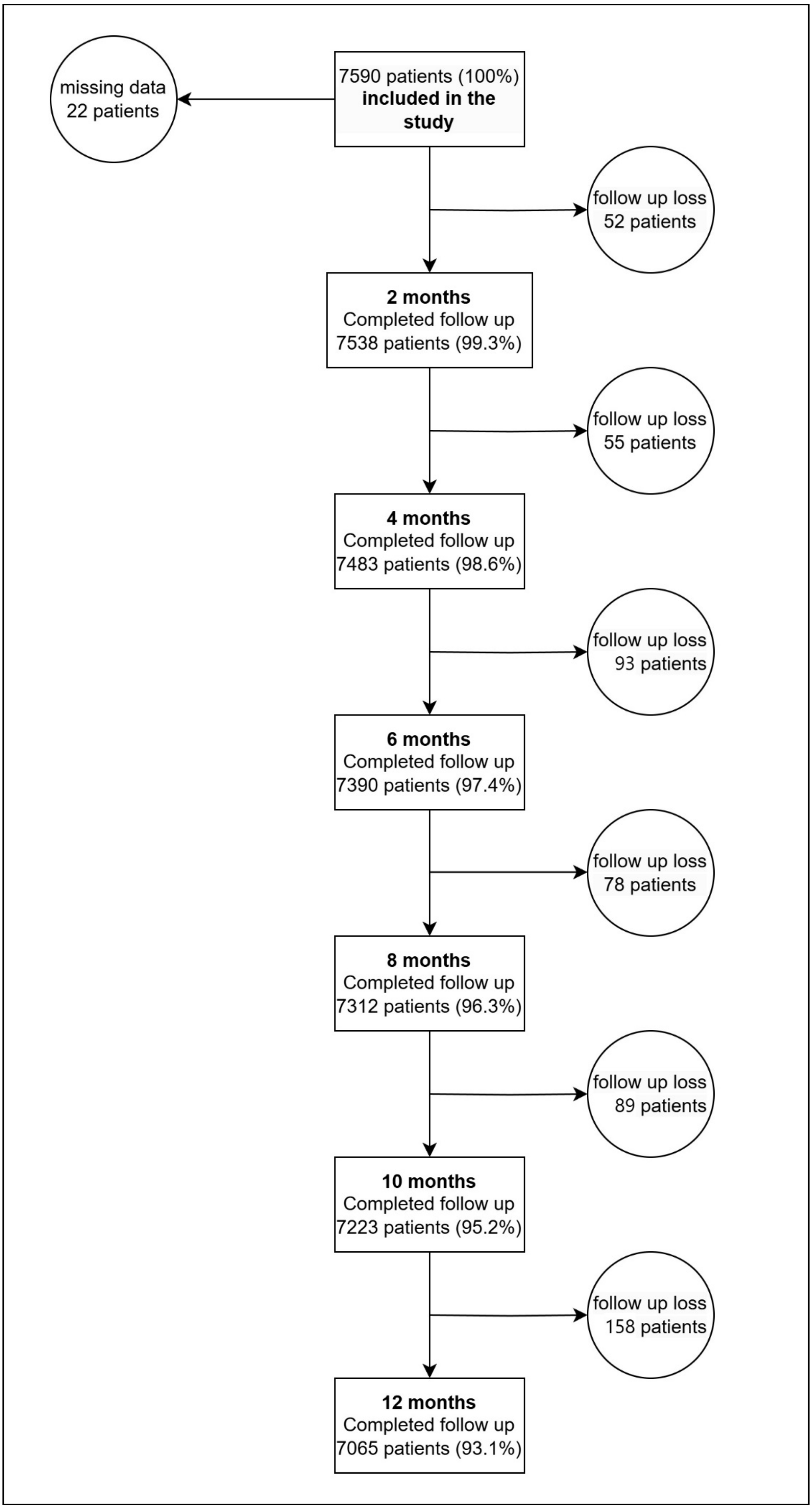
missing data 22 patients
7590 patients (100%) **included in the study**
follow up loss 52 patients
2 months Completed follow up 7538 patients (99.3%)
follow up loss 55 patients
4 months Completed follow up 7483 patients (98.6%)
follow up loss 93 patients
6 months Completed follow up 7390 patients (97.4%)
follow up loss 78 patients
8 months Completed follow up 7312 patients (96.3%)
follow up loss 89 patients
10 months Completed follow up 7223 patients (95.2%)
follow up loss 158 patients
12 months Completed follow up 7065 patients (93.1%)

Figure 2. Number of patients attending follow-up appointments

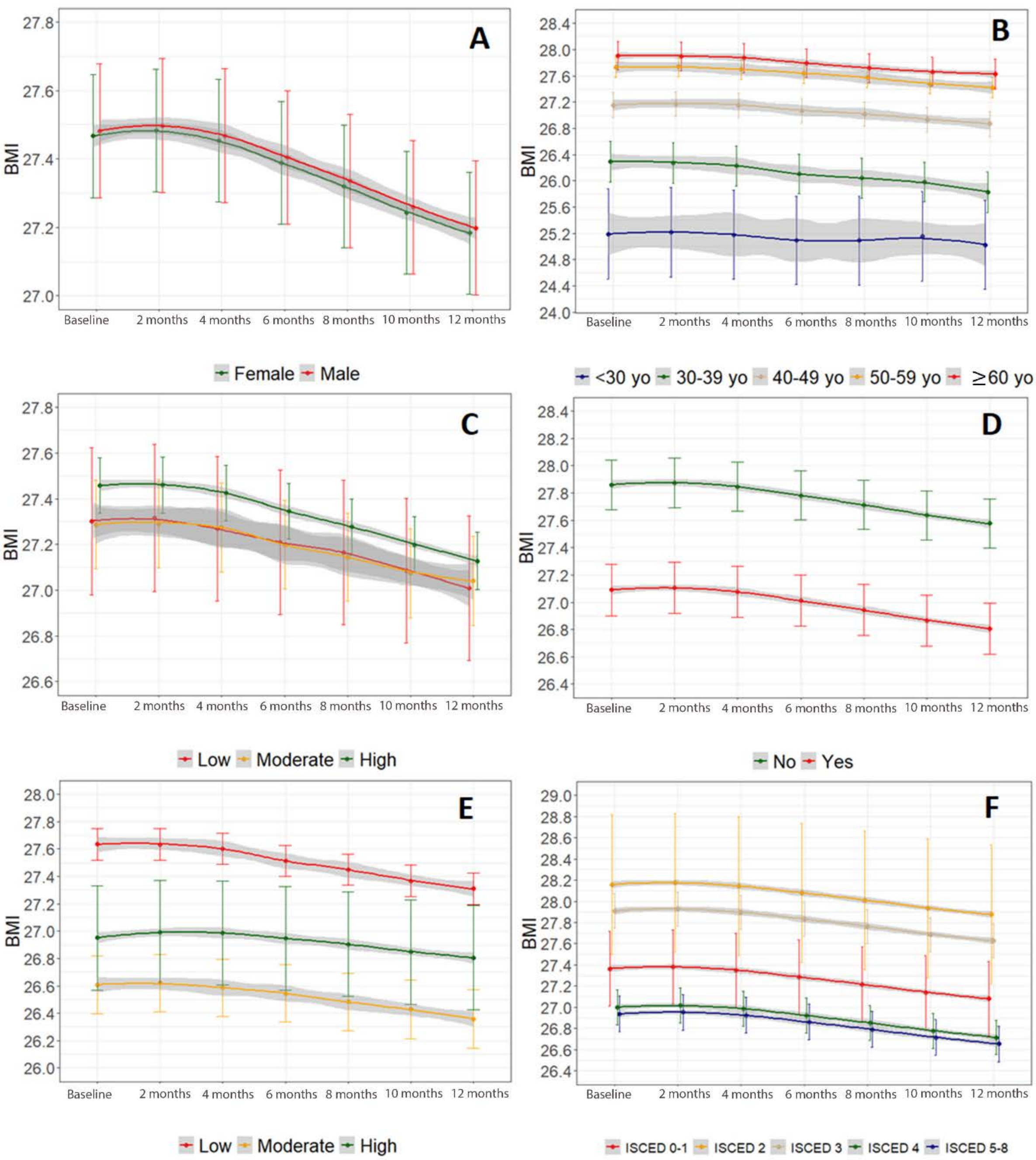

Figure 3. BMI reduction in all subgroups. **A.** Sex. **B.** Age groups. **C.** Stress level. **D.** Smoking. **E.** Physical activity. **F.** Education — levels

Values presented as marginal means (points) with 2-sided 95% CI (whiskers) as well as filled locally estimated scatterplot smoothing (curve) and two-sided 95% CI for the fit (shaded area)

Abbreviations: BMI, body mass index (expressed in kg/m^2); CI, confidence interval; ISCED, international standard classification of education

Figure 4. Factors affecting BMI's change

Color red represents increase in BMI, color green represents decrease in BMI

Abbreviations: DBP, diastolic blood pressure; FU, follow-up; LDL, low-density lipoprotein cholesterol; SBP, systolic blood pressure; TG, triglycerides; WHR, waist-hip ratio; other — see Figure 3