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ORIGINAL ARTICLE

Changes in body weight in various population groups in Poland during the COVID-19 pandemic – a comparison of two cross-sectional studies

Maciej Białorudzki[1,A-F], Józef Haczyński[1,2,D,F], Radosław Sierpiński[3,E-F], Joanna Mazur[1,A,C,E-F], Alicja Kozakiewicz[1,D,F], Zbigniew Izdebski[4,5,A-B,E-F]

[1] *Department of Humanization of Health Care and Sexology, Collegium Medicum, University of Zielona Góra, Poland*
[2] *Faculty of Management, Warsaw University, Poland*
[3] *Faculty of Medicine, Collegium Medicum, Cardinal Stefan Wyszyński University, Warsaw, Poland*
[4] *Department of Biomedical Aspects of Development and Sexology, Faculty of Education, Warsaw, Poland*
[5] *Faculty of Medicine, University of Warsaw, Poland*
A – Research concept and design, B – Collection and/or assembly of data, C – Data analysis and interpretation, D – Writing the article, E – Critical revision of the article, F – Final approval of the article

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Abstract

Introduction and Objective. The disruption of daily activities caused by the COVID-19 pandemic had health consequences, especially during peak lockdown periods. The aim of the study is to assess the impact of the first year of the COVID-19 pandemic on the process of weight change among Polish adults.

Materials and Method. Two representative studies involving Polish adults aged 18–65 years were conducted, the first in June 2020 (N = 2527, from the perspective of the last 2–3 months), and the second a year later, in June 2021 (N = 2087, covering the last 12 months). Both surveys included two groups of respondents, and conducted using the CAWI method – computer-assisted web interview.

Results. In the first period of the COVID-19 pandemic, there were more individuals with obesity than a year later (18.7% vs 19.9%), and more respondents reported weight change in 2020 than in 2021 (53% vs 49.6%). In both surveys, women were more likely to report weight gain than men ($p<0.001$). Statistically significant factors for weight change in 2020 and 2021 were gender, age, and in 2021, education and relationship status. Multinomial logistic regression showed that BMI, age of 18–29 and 30–49, being male, and education below high school, was significant for weight gain. While for weight loss, BMI, age 18–29 and 30–49, being male, and year of study, were statistically significant.

Conclusions. The findings confirmed that body weight changed throughout the pandemic, depending on the time of the pandemic and selected socio-demographic factors.

Key words

BMI, COVID-19 pandemic, Polish population, weight loss, weight gain

INTRODUCTION

The COVID-19 pandemic, an acute respiratory disease caused by the SARS-CoV-2, led to a global economic and health crisis, which also impacted on social life. Disruptions to daily routines additionally had behavioural implications, particularly at peak times of lockdowns [1–4]. At this stage of the COVID-19 pandemic, the literature was filled with studies on weight change during that period. However, it is important that such changes are analyzed at different stages of the pandemic, taking into consideration the changes in economic, demographic, social, and cultural or information changes, which were ongoing.

Many cross-sectional studies, however, included only a single weight measurement and a single BMI calculation, thereby neglecting the dynamics of body weight change during such a difficult time as the pandemic. When it comes to the health effects, apart from the obvious health effects of the SARS-CoV-2 infection, the pandemic induced adverse lifestyle changes, inducing to engage less in health-promoting behaviours.

The worldwide prevalence of overweight and obesity is now high and on the rise. In 2016, 39% of the world's adult population (39% of men and 40% of women) were overweight, and about 13% obese (11% of men and 15% of women). It has been estimated that the global prevalence of obesity nearly tripled between 1975 – 2016 [5]. Weight gain is the result of an imbalance between total energy intake and total energy expenditure. Energy expenditure varies with changes in body weight, and the balance between energy intake – in the form of calories – and the basal energy requirement of the body is a key determinant of weight control [6]. The substantial and sustained increase in total food intake over the past three decades is thought to have increased body weight in the global population [7]. The increase in body weight and the prevalence of obesity can also be linked to

✉ Address for correspondence: Maciej Białorudzki, Department of Humanization of Health Care and Sexology, Collegium Medicum, University of Zielona Góra, Poland
E-mail: mbialorudzki@uz.zgora.pl

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the industrialization of the food system, which includes increased sales of highly processed foods [8, 9], and it has been suggested that excessive consumption of these foods is associated with weight gain [10]. Also, reduced mobility, decreased physical activity, or increased leisure TV and screen time, may have resulted in weight gain. In addition, stress and boredom were more common during the pandemic [11]. Psychological variables, such as boredom [12] and chronic stress [13], increase hunger and the consumption of unhealthy foods and snacks, which can also result in weight gain.

Individuals with overweight and obesity show more disordered eating behaviours, such as eating food while not feeling hungry and frequent snacking [14]. They also reported consuming more food and snacking more frequently while at home during the pandemic lockdowns [15]. In Spain, it was reported that during the national lockdown compared to the pre-pandemic time, people's diets were higher in calories [16]. In Poland, an online survey of 1,097 adults showed an increase in snacking (52%) and eating (43%) during the national quarantine associated with the COVID-19 pandemic [17]. These adverse changes can be linked to staying home and social distancing, both of which have negative impacts on healthy eating habits [18]. Weight loss efforts were hampered during COVID-19 and a survey conducted during that time showed that 69.6% of patients found weight loss goals more difficult to achieve [19].

Weight loss is accompanied by endocrine adaptations that increase appetite and decrease satiety [20]. Consequently, these adaptations impede continuous weight loss and make long-term weight management difficult. In addition, behavioural changes following weight loss also hinder further weight loss or weight maintenance [21]. It has been suggested that long-term maintenance of lost weight is much more difficult, and weight regain at a later stage is commonplace [22–24]. Many people who managed to reduce weight eventually regained it in the long term [25]. A review of studies on people who lost 5% or more of their body weight, found that these individuals regained all their lost weight over the next four years if no further weight reduction interventions were used [26]. And this may result in a lack of desire to modify behaviours and readopt those promoting weight loss [27]. Despite current scientific knowledge of barriers to changing weight-loss behaviour, such as weakening motivation or decreasing self-regulation [28], strategies supporting weight regain prevention are limited.

Ensuring weight loss maintenance is critical to reversing the alarming rise in global obesity and reducing obesity-related comorbidities. To this end, long-term – lasting a year or longer – comprehensive weight maintenance programmess are recommended [29]. However, weight loss and its maintenance should not be the only measure of success. Instead, physicians and dieticians should support and encourage patients to sustainably improve eating habits and increase physical activity. Such lifestyle changes are likely to improve patients' long-term health, even in the absence of substantial weight loss [30]. Additionally, preventing weight gain from an early age may be more important than promoting later weight loss, as achieving long-term weight loss and maintaining it is difficult once a person has already become a part of those with obesity [31]. Chen et al. showed that approximately 80% of the population with obesity, as young adults went on to be people with obesity in middle or late adulthood [32]. Special attention should also be paid to men, who are under-represented in studies of weight loss programmes [33].

The analyses of the COVID-19 pandemic-related changes in body weight should also consider socio-demographic factors, including age and gender, which influence the prevalence of excess body weight [34]. Statistically significant weight gain was observed especially in people with overweight and people with obesity and later age [17]. In other studies, social and demographic aspects, such as age, gender, living alone, work activity, and education, were associated with weight change during the pandemic [35]. Therefore, when it comes to preventing weight gain, such factors as diet and physical activity should be analyzed along with socio-demographic factors. In the future, such analyses will be crucial in preventing weight gain or weight losses in particularly vulnerable individuals. It can be assumed that body weight change is associated with socio-demographic factors such as: gender, age, education, marital status, or employment.

Two large population-based studies conducted in two time periods, May – June 2020 and May – June 2021, made it possible to assess the changes that occurred during the pandemic in Poland in the context of weight change. It is also one of the few Polish studies to describe so extensively the functioning of society in the early months of the pandemic, and more than a year after the pandemic outbreak. This allows for a comparison of different social groups in the two time periods of the 2020 and 2021 study. The aim of the analysis was to determine the association between body weight change and social and selected demographic factors at the two stages of the COVID-19 pandemic. Weight change was used as the main outcome variable and gender, age, education relationship status, and employment status as the main social and demographic indicators. The mean BMI and mean change in body weight (kg) were also presented, together with a set of indicators and associations during the pandemic stage.

The authors of the current study therefore hypothesize that social and demographic factors would be differentiating factors for weight change during the COVID-19 pandemic, and aimed to answer the following research questions:

1. Which selected social and demographic factors were significant predictors of weight change?
2. Which factors affected changes within body mass?
3. How did predictors of weight loss and weight gain difference between the two study periods?

MATERIALS AND METHOD

Study design and sample. The study drew on the results from two cross-sectional surveys on the health and sexuality of Polish adults conducted during the COVID-19 pandemic, one year apart. The first study was conducted in May – June 2020, allowing assessment of the first three months of the pandemic; the second survey, exactly a year later, aimed to assess the last 12 months. The respondent belonged to a nationwide sample and came from an online panel of a company specializing in research on Polish men and women's health (IQS Sp. z o.o., Warsaw, Poland). The company runs research into various aspects of human health. The panel sample comprised 100,000 active respondents. The surveys are representative with quota sampling based on gender,

age and place of residence (province, county, size of town) – reflecting the Polish population.

At every stage of data collection, the research team had substantive supervision and insight into the survey collection system. These were web-based surveys (CAWI-computer assisted web interview), organized on an *ad hoc* basis in connection with the COVID-19 pandemic by the same researchers. On the technical side, the surveys were carried out by an external company, which was responsible for sampling and supervising the survey process. All patients consented to participate in the study and to have their data used by the authors. Both studies were approved by the research Ethics Committee. Data were obtained from 3,000 and 2,500 Polish adults aged 18–87 years (median age 45), in 2020 and 2021, respectively. A total of 4,613 respondents (median age 41 years) were qualified for further analysis – 2,527 and 2,086 in the two studies, respectively. Exclusion criteria were main variables of body mass change, age and gender. However, data missing in social variables characterizing respondents was accepted. The mean age of respondents was 41.8 (SD=13.8) for the 2020 study and 41.9 (SD=13.4) for the 2021 study.

The thematic scope of the questionnaire, the research procedure, and mode of obtaining participant consent, were approved in both cases by the Ethics Committee of the Faculty of Education at the University of Warsaw (Decision No. 6/2020 and 9/2021).

The questionnaire. The complete 2020 research tool was a questionnaire comprising 500 variables grouped in 16 theme blocks. The questionnaire was designed to take no more than 25 minutes to complete, with some questions and groups of questions appearing optionally, depending on previous responses. A significant portion of the questions asked about the previous 2–3 months, when strict measures of social isolation were introduced in Poland. Following the initial analysis of the 2020 data and a review of the available literature, minor changes were made to the 2021 questionnaire. The time to complete the survey was shortened and the scope of the survey questions was adopted to the knowledge about the pandemic available at the time of the survey. The 2021 tool contained over 400 variables grouped in 14 theme blocks. The questionnaire was designed to take no more than 20 minutes to complete, and, as in the 2020 questionnaire, some questions appeared optionally. When the respondents were asked in June 2020 about the previous 2 – 3 months, the authors we decided to include the initial phase of the pandemic in the 2020 survey. In the second survey in June 2021, the authors decided to extend the time frame to 12 months to ensure continuity of observation since the beginning of the pandemic. Most of the questions remained unchanged to ensure data comparability.

Research tools and measures. In both studies (2020 and 2021), the respondents were asked their current weight (kg) and height (cm), and the BMI values were calculated according to the formula: weight in kilograms divided by height in meters squared (kg/m^2). For normal weight a BMI of 18.5–24.99 was used, for overweight, a BMI of 25- 29.99, and for obesity ->30. Body weight and its change were assessed using a self-report question. In 2020, respondents were asked: 'How did your body weight change over the past 2–3 months?'; and in 2021, the question was: 'How did your body weight change over the past year?' In both questionnaires, the response options were: 'increased', 'remained the same', or 'decreased'. By choosing 'increased' or 'decreased', respondents reported how much their body weight changed in kilograms (weight change was considered to be a decrease or increase of at least 1 kg). For the 'no change' answer category, zero change was assumed, and weight loss was treated as a negative change. Weight change was treated as the main dependent variable.

Overall, body weight variables included the following primary variables, obtained from the questionnaire, and derived variables:

- BMI and its categories: normal, overweight, obesity.
- Change in body weight as: weight loss, no change, increase.
- Change in body weight: expressed in kg.

To describe weight change by demographic and social characteristics, the following factors and groups were included:

- Gender – with male and female categories.
- Age – with 3 age categories: 18–29 years; 30–49 years; 50–65 years
- Education – recoded from 12 into 3 categories: < secondary, secondary, > secondary.
- Relationship status – with 2 categories: living in a relationship, living alone (single).
- Employment status – with 2 categories: employed, unemployed.

The above questions were identically worded across the 2 survey groups.

Statistical analysis. To examine the associations between categorized variables, the Chi-square test was used. Mean (SD) values were presented, testing for differences with non-parametric Mann-Whitney (2 groups) or Kruskal-Wallis (more than 2 groups) tests.

As part of the multivariate analysis, a multinomial logistic regression was conducted, including weight change as a dependent variable categorized as 'weight loss', 'no weight change', and 'weight gain'. In addition, a general linear model (GLM) with body weight change (kg) as a dependent variable was presented in a graphic format. A p-value of <0.05 was considered significant for all tests in the study. Statistical analyses were performed using IBM SPSS Statistics v. 28 software.

RESULTS

Sample characteristics. Sample characteristics of the 2020 and 2021 studies are shown in Table 1 which compares data from the 2 studies. There was a small difference between the 2 survey groups. Both studies were population-based, therefore, all the variables were estimated at the same level. The largest difference was in the employment category, with 58.9% of the 2020 survey respondents declaring having a job, compared to 61.6% of the 2021 survey. Consistent with the inclusion criterion, participants' ages ranged from 18 – 65 years, with mean age of 41.8 ± 13.8 for the 2020, study and 41.9 ± 13.4 for the 2021 study. Total mean age was 41.8 ± 13.65, and the median was close to the mean value (41). The largest group in both surveys was in the 30–49 age range (2020–45.1%; 2021–46.2%).

Table 1. Sample characteristics

	Repeated cross-sectional surveys	
	2020 N = 2527	2021 N = 2086
Gender		
Male	1,223 (48.4%)	1,022 (49%)
Female	1,304 (51.6%)	1,064 (51%)
Chi-square	P = 0.687	
Age (years)		
18–29	538 (21.3%)	440 (21.1%)
30–49	1,140 (45.1%)	964 (46.2%)
50–65	849 (33.6%)	682 (32.7%)
Chi-square	P = 0.742	
Education		
< Secondary	1,116 (44,2%)	896 (43%)
Secondary	855 (33.8%)	742 (35.6%)
> Secondary	556 (22%)	448 (21.5%)
Chi-square	P = 0.474	
Marital Status		
Single	610 (24.1%)	538 (26%)
In a relationship	1,917 (75.9%)	1533 (74%)
Chi-square	P = 0.152	
Employment		
Yes	1,447 (58.9%)	1249 (61.6%)
No	1,008 (41,1%)	778 (38.4%)
Chi-square	P = 0.068	
BMI		
Normal weight	1,198 (47.4%)	948 (45.4%)
Overweight	850 (33.6%)	722 (34.6%)
Obesity	472 (18.7%)	416 (19.9%)
Chi-square	P = 0.332	

Minor data misses in variables of marital status and employment, and BMI

Univariate analysis. Table 2 presents the characteristics of declared body weight changes at various stages of the pandemic, grouped by gender. In both 2020 and 2021, the majority of respondents reported no change in their body weight. However, in 2021, a higher percentage of participants declared weight loss compared to 2020 (20% vs 15.7%). Conversely, in 2020, respondents were more likely to report weight gain (33.9% vs 33%). The mean weight gain (kg) was higher in 2020, while the mean BMI was higher in 2021 compared to 2020.

Both samples were gender-balanced, with women accounting for 51.6% and 51% of respondents in 2020 and 2021, respectively. The statistical significance of the Chi-square was determined by analyzing the declared changes in body weight by gender ($p < 0.001$) for both samples. During the early stage of the pandemic in 2020, more women reported weight gain compared to men (29.5% vs. 38%). Similarly, in the next stage of the pandemic, more women than men reported weight gain (37.2% vs 28.5%). The mean BMI values for both genders were higher in the second stage of the study. In contrast, the mean weight change was greater for both gender in 2020. Statistical significance was determined using the Mann–Whitney U test when analyzing BMI ($p < 0.001$).

Table 2. Weight change characteristics by gender

	Total	Male	Female
2020	N = 2527	N = 1223	N = 1304
Lost some weight	397 (15.7%)	173 (14.1%)	224 (17.2%)
Same weight	1,274 (50.4%)	689 (56.3%)	585 (44.9%)
Gained some weight	856 (33.9%)	361 (29.5%)	495 (38%)
Chi-square*		P < 0.001	
Mean BMI (SD)	25.97 (5.01)	26.79 (4.83)	25.20 (5.06)
Mean weight change in kg (SD)	+0.90 (4.42)	+0.72 (4.31)	+1.08 (4.52)
Mann-Whitney U Test* BMI		P < 0.001	
2021	N = 2086	N = 1022	N = 1064
Lost some weight	418 (20%)	190 (18.6%)	228 (21.4%)
Same weight	981 (47%)	541 (52.9%)	440 (41.4%)
Gained some weight	687 (33%)	291 (28.5%)	396 (37.2%)
Chi-square*		P < 0.001	
Mean BMI (SD)	26.26 (5.16)	26.81 (4.78)	25.74 (5.45)
Mean weight change in kg (SD)	+0.74 (6.57)	+0.46 (6.58)	+1.01 (6.56)
Mann-Whitney U Test* BMI		P < 0.001	

*Chi-square to compare men and women; * Mann-Whitney U Test for BMI tested variable, gender grouping variable

Table 3 shows the characteristics of weight changes grouped by respondents' age. In the initial stage of the 2020 pandemic, the highest percentage of respondents aged 18–29 years (39.4%) declared weight gain, compared to other age groups. In the later stage of the 2021 pandemic, those aged 18–29 years also reported the most significant weight fluctuations (combined 61.2% for decrease and increase). Across both 2020 and 2021, all age groups were more inclined to declare weight gain than weight loss. The greatest weight stability in both surveys was reported by individuals aged 50–65 years (56.1% in 2020; 55.4% in 2021). When comparing mean BMI values across survey stages, respondents in all age groups in 2021 exhibited higher BMIs compared to 2020.The highest

Table 3. Weight change characteristics by age

	18–29 years	30–49 years	50–65 years
2020	N = 538	N = 1140	N = 849
Lost some weight	113 (21%)	179 (15.7%)	105 (12.4%)
Same weight	213 (39.6%)	585 (51.3%)	476 (56.1%)
Gained some weight	212 (39.4%)	376 (33%)	268 (31.6%)
Chi-square*		P < 0.001	
Mean BMI (SD)	23.55 (4.53)	26.14 (4.99)	27.28 (4.80)
Mean weight change in kg (SD)	+1.04 (4.73)	+0.94 (4.91)	+0.77 (3.42)
Kruskal-Wallis test* BMI		P < 0.001	
2021	N = 441	N = 964	N = 692
Lost some weight	98 (22.4%)	205 (21.3%)	114 (16.7%)
Same weight	171 (38.8%)	432 (44.8%)	378 (55.4%)
Gained some weight	171 (38.8%)	327 (33.9%)	190 (27.9%)
Chi-square*		P < 0.001	
Mean BMI (SD)	23,96 (4.70)	26.42 (5.10)	27.53 (5.03)
Mean weight change in kg (SD)	+1.09 (6.03)	+0.79 (7.11)	+0.45 (6.10)
Kruskal-Wallis test* BMI		P < 0.001	

*Chi-square test to compare age categories; *Kruskal-Wallis test for BMI tested variable, age grouping variable

Table 4. Weight change characteristics by education

	Education		
	< Secondary	Secondary	> Secondary
2020	N = 1116	N = 855	N = 556
Lost some weight	179 (16%)	138 (16.1%)	80 (14.4%)
Same weight	595 (53.3%)	406 (47.5%)	273 (49.1%)
Gained some weght	342 (30.6%)	311 (36.4%)	203 (36.5%)
Chi-square*		P = 0.033	
Mean BMI (SD) Mean weight change in kg (SD)	26.39 (5.42) +0.88 (4.81)	25.64 (4.76) +1.00 (4.44)	25.63 (4.45) +0.80 (3.49)
Kruskal-Wallis test* BMI		P = 0.019	
2021	N = 897	N = 742	N = 448
Lost some weight	188 (21.1%)	134 (18.1%)	95 (21.2%)
Same weight	418 (46.6%)	360 (48.5%)	203 (45.3%)
Gained some weight	290 (32.3%)	248 (33.4%)	150 (33.5%)
Chi-square*		P < 0.001	
Mean BMI (SD) Mean weight change in kg (SD)	26.71 (5.33) +0.69 (7.15)	25.74 (5.02) +0.84 (6.13)	26.22 (4.97) +0.68 (6.08)
Kruskal-Wallis test* BMI		P < 0.001	

*Chi-square test to compare education category; * Kruskal-Wallis test for BMI tested variable, education grouping variable

mean change in weight (kg) was observed in respondents aged 18–29 years +1.09 kg (SD=6.03) in 2021 and +1.04 kg SD (4.73) in 2020. In contrast, the smallest mean change in body weight (kg) was reported by respondents aged 50–65 years in 2021 +0.45 kg (SD=6.10). Statistical significance of Chi-square was obtained at both pandemic stages by analyzing declared weight changes by age (p< 0,001). Additionally, significance was found by analyzing current BMI and BMI before weight change by age (p< 0.001).

Table 4 shows the characteristics of weight changes grouped by respondents' education. In the 2 phases of the pandemic, those with more than a high school education were most likely to report weight gain in 2020 (36.5%) and 2021 (33.5%). In 2020, those with less than secondary education reported the highest mean BMI (26.39; SD = 5.42). Similar results were obtained in 2021, where having less than secondary education was associated with the highest mean BMI (26.71; SD = 5.33). In 2020, those who reported the lowest average BMI had secondary education (25.63; SD = 4.45). However, in the second stage of the pandemic in 2021, the lowest mean BMI was reported by those with high school education (25.74; SD = 5.02). In 2021, statistical significance was obtained when analyzing BMI by education (p < 0.001).

Table 5 presents the characteristics of weight change grouped by respondents' relationship status and employment status. In the initial stage of the 2020 pandemic, individuals living alone were more likely to report weight loss than those in a relationship (18% vs 15%). Conversely, in the second stage of the pandemic in 2021, partnered individuals were most likely to report weight loss (20.2%). In 2020, greater weight stability was reported by those living in a relationship (50.8% vs 49.3%) and in 2021 by those living alone (49.1% vs 46.1%). Living in a relationship was associated with a higher average BMI at both stages of the pandemic. Statistical significance was obtained in the two pandemic stages when analyzing the current mean BMI and before weight change BMI by relationship status (p < 0.001).

Unemployed respondents were more likely to report weight gain in 2020 and 2021, compared to those who were employed (in 2020, 35.3% vs 33.4%; in 2021, 35.6% vs 31.5%). Respondents who were not working in 2020 were more likely to report weight loss than those who were employed at that time (16.9% vs 15%). In contrast, individuals employed in 2021 were more likely to report weight loss than unemployed individuals (20.5% vs 19.3%). Those without a job in 2020 had the lowest mean BMI (25.77; SD = 5.31). The highest mean change in body weight (kg) in the 2 pandemic stages was reported by those who were unemployed.

Table 5. Weight change characteristics by relationship and employment

	Marital status		Employment	
	Single	In a relationship	Yes	No
2020	N = 610	N = 1917	N = 1447	N = 1008
Lost some weight	110 (18%)	287 (15%)	217 (15%)	170 (16.9%)
Same weight	301 (49.3%)	973 (50.8%)	746 (51.6%)	482 (47.8%)
Gained some weight	199 (32.6%)	657 (34.3%)	484 (33.4%)	356 (35.3%)
Chi-square*	P = 0.191		P = 0.167	
Mean BMI (SD) Mean weight change in kg (SD)	25.10 (4.98) +0.82 (4.74)	26.25 (4.99) +0.93 (4.32)	26.17 (4.75) +0.91 (4.06)	25.77 (5.31) +0.96 (4.89)
Mann-Whitney U Test* BMI	P < 0.001		P = 0.008	
2021	N = 538	N = 1533	N = 1249	N = 778
Lost some weight	107 (19,9%)	309 (20,2%)	256 (20,5%)	150 (19,3%)
Same weight	264 (49,1%)	707 (46,1%)	600 (48%)	351 (45,1%)
Gained some weight	167 (31%)	517 (33,7%)	393 (31,5%)	277 (35,6%)
Chi-square*	P = 0.444		P = 0.156	
Mean BMI (SD) Mean weight change in kg (SD)	25.65 SD(5.59) +0.66 SD(5.67)	26.50 SD(4.99) +0.77 SD(6.88)	26.16 SD(4.79) +0.43 SD(6.84)	26.49 SD(5.77) +1.24 SD(6.17)
Mann-Whitney U Test* BMI	P < 0.001		P = 0.622	

* Chi-square test to compare education category; * Mann-Whitney U Test for BMI tested variable, age grouping variable

Table 6. Multinomial logistic regression for the declared body weight change (N=4482)

Body weight gain					Body weight loss			
	OR	95% CI(OR)		P	OR	95% CI(OR)		P
		Lower bound	Upper bound					
Constant				**<0.001**				**<0.001**
BMI (cont)	1.103	1.087	1.119	**<0.001**	1.037	1,019	1.056	**<0.001**
Age 18–29 years	2.905	2.382	3.543	**<0.001**	2.590	2,040	3.289	**<0.001**
Age 30–49 years	1.569	1.340	1.837	**<0.001**	1.570	1.292	1.909	**<0.001**
Age 50–65 years ref	1				1			
Gender male	1.966	1.714	2.255	**<0.001**	1.634	1.385	1.929	**<0.001**
Gender female ref	1				1			
Year of study 2020	0.984	0.860	1.126	0.817	0.733	0.623	0.862	**<0.001**
Year of study 2021 ref	**1**				**1**			
< Secondary education	0.694	0.581	0.829	**<0.001**	0.873	0.704	1.083	0.217
Secondary education	0.873	0.728	1.049	0.147	0.868	0.692	1.089	0.221
> Secondary education ref	1				1			

Multivariate analysis. Table 6 shows the results of the multivariate multinomial logistic regression. The outcome variable is weight change (loss and gain), with no weight change assigned as the reference category. Sociodemographic characteristics, pandemic stage (as year of study) and BMI were used as explanatory variables.

The most significant predictors of declared weight gain were: BMI, age, gender, and education, whereas for declared weight loss: BMI, age, gender and pandemic stage (year of study).

The results of the GLM analyses with the explanatory variable 'change in body weight in kg' allowed the results to be presented in a graphic format. Socio-demographic characteristics, pandemic stage (year of study), and BMI were used as explanatory variables. Principal analyses and two-way interaction were used. Figure 1 show the results of the analyses of the general model with the two-way interactions.

Statistical significance was obtained at $p < 0.001$ for the interaction of the 3factors. The analysis confirms that BMI affects weight change in interaction with the year of the study. The interaction results show the largest weight gain in population with obesity respondents in both 2020 and 2021, with a larger gain in 2021. A loss in weight was found only in 2021 in respondents with normal weight.

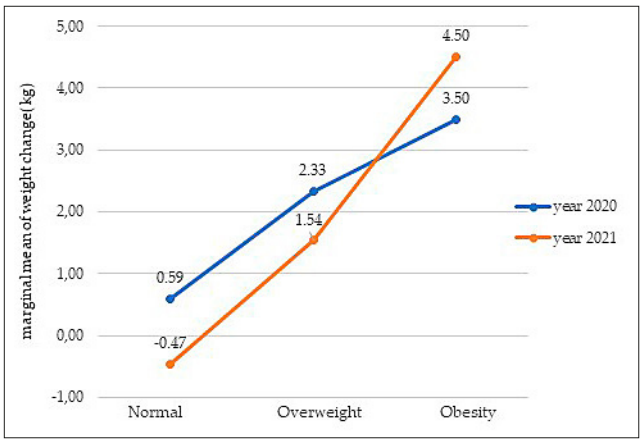

Figure 1. Interaction between BMI and pandemic stage as a predictors of body weight change

DISCUSSION

The same statistical method was applied in both study periods, and respondents were given questions with identical wording, which allowed for data analyses at 2 time points during the pandemic, in 2020 and 2021.

In response to the COVID-19 pandemic outbreak, unprecedented measures of isolation and social distancing were introduced to curb the spread of SARS-CoV-2 [36]. These restrictions substantially changed social life, and also affected public health [37]. Pandemic-induced changes affected people's eating habits, leading to increased calories consumption, less physical activity, and eventually to weight gain [37–39]. Understanding the mechanisms and determinants of weight change during the pandemic with temporary lockdown is vital for public health. Identifying groups at a particular risk for weight change will allow the development of a strategy for preventing weight gain in the event of similar emergencies [40].

Weight change during the pandemic. A cross-sectional repeated internet-based study conducted early in the pandemic in 2020, and then a year later in 2021, included a total of 4,614 respondents aged 18–65 years. Respondents over the age of 65 were excluded from the sample due to the observed prevalence of a population with overweight or with obesity, and at the same time, cachexia, across this age group [41]. Weight gain was reported by the adults participating in the study during the pandemic, with higher BMI values found in both male and female respondents in the second year of the pandemic. Evidence showed that before the pandemic, adults gained weight gradually. In 2019, 57 % of the adults – compared to slightly over 53% in 2014 – reported excessive weight (people with overweight or people with obesity) [42]. In the 2020 survey, 52.3% of the respondents had excessive body weight. In the second part of the study, the number of respondents reporting excess body weight increased to 54.5%. In the 2020 study, 33.9% of respondents gained weight early on in the pandemic, and 15.7% reported losing weight. These findings are consistent with the results obtained by another Polish study which showed an increase in body weight in 28.3%, and weight loss in 12.9% of the study population [43].

Research findings from other countries also reported weight gain during the pandemic [38, 40].

Weight gain analysis in the 2020 study included the last 2–3 months before the time of data collection. Weight gain during this time can be linked to changes in eating habits, limited physical activity, and increased pandemic-related stress [11, 16, 17, 44, 45]. It is important to note that individuals with a higher BMI at the beginning of the pandemic gained more weight early on in the pandemic than in the later stages. There is thus a need to develop period-specific isolation programmes and measures that would target population groups with different body weight, and account for times of abrupt changes in people's lifestyles.

Age vs. weight and its change. Respondents' age is important in terms of body weight change during the pandemic in Poland. Those aged 18–29, men and women alike, reported not only greater weight gain but also greater weight loss in both stages of the pandemic. Additionally, weight gain in this particular age group may be linked to remote learning, related stress, limited physical activity, restrictions regarding mobility, and a sedentary lifestyle [46]. Young adults, a group characterized by an increased desire of social belonging, search for their own identity, and thereby also at an increased risk of mental health problems, were particularly affected by the adverse effects of social isolation and a sense of loneliness. To cope with stress and negative emotions, people engaged in unhealthy eating behaviours, such as binge eating to reduce stress, and overeating in terms of both quantity and quality, and nighttime eating [19, 47, 48].

Gender, body weight and its change. In the studies of 2020 and 2021, women, unlike men, were more likely to gain weight, reporting greater weight gain (kg). Apart from limited physical activity and dietary changes, the additional burden of being a mother and caring for children kept at home due to stay-at-home orders, might have adversely affected women's mental and physical well-being [40]. Similar results related to weight change were also found in another Polish study among Polish women [49]. Home cooking and lifestyle change are other factors affecting weight change in women, a finding also reported in other studies [50].

Relationship vs. weight and its change. Singles, compared to those in a relationship, were particularly affected by social isolation in the initial stage of the pandemic. It was found that in 2020, those who were single (50.7%) were more likely to report weight gain. A year later, in 2021, more partnered individuals (53.9%) reported weight change. A British study also found that greater weight gain was found in singles than in partnered individuals [51].

Normal weight is one key aspect of physical appearance and perceived self-attractiveness, and attractiveness perceived by others. Married individuals are usually under less pressure to take care of their looks than individuals living with unmarried partners, and the role of a spouse often promotes skipping meals, eating highly processed foods, and exercising less [52]. This study shows that living in a relationship was associated with a higher BMI, both before and during the pandemic.

Education vs. body weight and its change. The study revealed that the level of education correlated with the weight change. People with a high school education or above reported the highest weight gain, whereas the highest weight loss was found among those with above high school education. Respondents with below high school education had the highest BMI, which may be linked to their lack of concern for health, lower economic status, and their lack of concern for the quality of food consumed.

During the COVID-19 pandemic, most people reported gaining weight, with some differences in subgroups broken down by demographic and social characteristics. Evidence from a large-scale Polish sample provides information on the impact of lockdown on weight gain, and made it possible to identify the most vulnerable population groups. The study findings may be used in developing a strategy to combat unhealthy weight gain during a pandemic, and in taking health-promoting and health preventive measures after the pandemic, targeting individuals at the greatest risk for weight gain.

More large-scale studies aiming to identify more risk factors for weight gain and weight loss during the pandemic are necessary; therefore, health-promoting strategies must be introduced to prevent unhealthy changes in weight. Public health interventions should target the younger populations with the aim of changing their consumption of food habits and physical inactivity patterns adapted in the early stages of the pandemic. Such measures would ensure the reversal of adverse long-lasting habits which would eventually contribute to chronic and costly health problems.

Limitations of the study. Because the study was cross-sectional, causality could not be inferred, and due to the lack of longitudinal observation, the study did not allow tracing of the trajectory of change. However, despite the limitations, the results of studies indicate which populations are particularly vulnerable to weight gain. Also, another limitation, considering the assessment of the causes of weight change, was that it did not analyze eating behaviours, which would provide important information regarding the body weight change. A sedentary lifestyle may reduce resting energy expenditure by 10–50%, thereby contributing to increased weight gain, even without changing eating habits [53]. Therefore, elements of physical activity should be included in a further study of body weight change. In addition, the weight change data were self-reported and thus subjective, which might have resulted in underestimating or overestimating these parameters. However, other studies indicate that declared BMI is highly correlated with actual BMI [54]. Next, the study respondents of the 2020 and 2021 study were not the same groups which, despite no differences in sample characteristics, might have affected eating habits or health-promoting behaviours. Another limitation is the follow-up period. In 2020, the weight change question was asked from the perspective of the last 3 months, while in 2021 it was asked from the perspective of the last year. And finally, the number of factors analyzed is limited, for example, psychological factors like stress level were not included [44].

CONCLUSIONS

The results of the 2 studies make some important contributions to empirical studies on body weight gain during the COVID-19 pandemic. The analyses included 2

repeated surveys, conducted in 2020–2021, in the sample of respondents aged 18–65 years. The analyses were stratified by the year of study and factors affecting weight loss and weight gain in the 2 study periods. It was found that women were particularly prone to gain weight during the pandemic. In addition, in both study periods, more respondents reported weight gain than weight loss. Multinominal regression showed that the year of study was statistically significant for weight loss.

The most urgent objectives for the future are the implementation of comprehensive educational programmes and the drawing of the attention of health professionals to issues related to effective and accessible methods of both obesity prevention, and weight reduction in society.

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