


Comparison of dietary habits before and after the COVID-19 restrictions in a population of children aged 7-14 participating in the PICTURE study

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ABSTRACT

Introduction: According to an OECD report, food consumption changed among children and adolescents in EU countries during the pandemic, but the findings are inconclusive. The aim of the study was to analyze changes in body mass and dietary habits in a cohort of children examined just before the pandemic and again in 2022, when COVID-19 restrictions had been lifted.

Material and methods: The analysis is based on selected data collected as a part of the Population Cohort Study of Wrocław Citizens (PICTURE). This article is based on data from children, who completed the first visit until the beginning of the COVID-19 pandemic, that is between 21st November 2019 and the 10th of March 2020. They were invited again in 2022 for a repeated measurement. The final analysis included 108 children (54.6% girls) with complete data at both time points.

Results: At the baseline, 81.5% of children had normal body weight, 12% had overweight and 2.8% had obesity. At the follow-up, 84.3% of children had normal body weight, 9.3% had overweight and 2.8% had obesity. Twenty percent (20.4%) of children reported a change in dietary habits during the pandemic. The average consumption of vegetables decreased in the children's group from 1.00 ± 0.75 servings/day to 0.90 ± 0.80 servings/day ($p = 0.05$). Average fruit intake decreased from 1.70 ± 1.13 servings/day to 1.45 ± 1.08 servings/day ($p = 0.02$). Average consumption of sugar-sweetened beverages increased from 0.28 ± 0.38 servings/day to 0.44 ± 0.69 ($p = 0.01$). The average consumption of poultry increased from 0.39 ± 0.25 servings/day to 0.51 ± 0.50 ($p = 0.05$).

Conclusions: During the pandemic dietary habits changed only slightly, but vegetables and fruit consumption among children and adolescents declined, while consumption of poultry and sugar-sweetened beverages increased. Consumption of vegetables, whole grains and dairy products both before and after the pandemic restrictions was lower than recommended.

KEY WORDS: PICTURE, cohort study, Poland, dietary habits, COVID-19, children.

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INTRODUCTION

Public health measures to contain the COVID-19 pandemic, including full lockdowns and suspension of in-person school activities, immensely influenced adolescents' physical and mental health [1].

The first SARS-CoV-2 infection in Poland was reported on 4th of March 2020 [2]. Later in March 2020, Poland introduced several strict public health measures to limit the spread of SARS-Cov-2. The restrictions included the cancellation of mass events; closure of schools, universities, kindergartens, restaurants and cultural institutions; closure of international borders (incoming citizens had to quarantine); closure of public places (including parks), limiting mobility of citizens; and limiting gatherings [3]. In Poland, schools were closed on March 10, 2020, and online teaching was implemented until April 2021 (except for the time when government allowed contact classes for children of early years of primary schools).

Studies suggest that beyond the direct impact of COVID-19 on health, the pandemic unfavorably influenced behavioral risk factors, including nutrition and physical activity [4]. All the changes can have potentially obesogenic effects, especially increased sedentary behaviors, lack of access to organized physical activity classes and sport activities, disruption of sleeping patterns, and increased consumption of sweets, sugar-sweetened beverages and ready-made foods [5]. Increase in body mass and changes in diet during the pandemic have been observed in adults [6, 7], but studies in children on the same topic are limited. Before the pandemic the burden of overweight and low physical activity in children and adolescents in Poland was already high. According to the Health Behavior in School-Aged Children Study (HBSC), 29.3% of 11-15-year-old boys and 13.7% of 11-15-year-old girls were overweight or obese, and in general, overweight prevalence increased in adolescents between 2002 and 2018 [8, 9].

The aim of this study was to analyze changes in body mass and dietary habits in a cohort of children examined just before the pandemic and again in 2022, when COVID-19 restrictions had been lifted.

MATERIAL AND METHODS

OVERVIEW

The analysis is based on selected data collected as a part of the Population Cohort Study of Wroclaw Citizens (PICTURE). It is a prospective cohort study including children aged 7-14 years and their parents/guardians, which started in November 2019. The study is organized by Wroclaw Medical University and the "Run for Health" foundation with the support of the Wroclaw Municipality. A sample of the population born between 2005 and 2012 in Wroclaw, Poland, was randomly drafted by the PESEL identification number. Drafted individuals were invited by traditional mail to participate in the study

with one of their parents/guardians. The full study protocol has been described in detail elsewhere [10]. Data are planned to be collected cyclically every two years, with a consistent protocol.

STUDY GROUP

This article is based on data from children who completed the first visit until the beginning of the COVID-19 pandemic, that is between 21st November 2019 and the 10th of March 2020 (baseline). A total of 120 children were identified as meeting those criteria. They were invited again in 2022 for a repeated measurement (follow-up). Twelve participants were excluded due to lack of contact or incomplete data. The final analysis included 108 children (54.6% girls) with complete data at both time points. Average age of the participants was 10.6 ± 2.08 years.

ANTHROPOMETRIC MEASUREMENTS

Body height was measured using a growth gauge (model SECA 213). Body mass was measured using a Tanita scale (model DC430 S MA). Both measurements were performed in accordance with the methodology of the OLAF study [11]. Similarly, the body mass index (BMI) was calculated and assessed according to BMI charts appropriate for age and sex following criteria from the OLAF study [11]. Children < 5th percentile were considered underweight; between 5th and < 85th percentile as having normal body mass; between 85th and < 95th percentile as overweight and $\geq 95^{\text{th}}$ percentile as obese.

DIETARY ASSESSMENT

Nutritional data were based on a short food frequency questionnaire (FFQ) including 27 groups of products commonly consumed in the Polish population: 1) vegetables, raw; 2) vegetables, cooked; 3) potatoes, cooked; 4) fruit; 5) milk, 1-2% of fat; 6) milk, 3.2% of fat; 7) cheese; 8) yoghurt/buttermilk/kefir; 9) cottage cheese/quark; 10) wholegrain bread/rye bread; 11) wheat bread/rolls; 12) groats (barley groats, buckwheat groats), brown rice; 13) white rice; 14) fish; 15) poultry (chicken/duck/turkey) with skin; 16) poultry (chicken/duck/turkey) without skin; 17) red meat (beef/pork); 18) hot dogs, sausages; 19) ham, pâté; 20) eggs; 21) sweets; 22) salty snacks; 23) sugar-sweetened beverages; 24) fruit juices; 25) fruity drinks, sweetened including flavored mineral waters; 26) natural mineral water; 27) fast food dishes. The questionnaire in this study was based on the nutritional questionnaire used in the "Let's get the kids moving" program [12] and short FFQ applied in the Prospective Urban and Rural Epidemiological Study (PURE) [13]. Every category of products had ascribed average serving size (e.g. 1 glass, 1 medium plate, 1 slice or an average serving in grams (90-120 g) in the case of meat/poultry). Participants were asked to assess the frequency of consumption of a given serving. Participants could choose among the following frequencies: 1) never; 2) 1-3 times

a month; 3) 1-2 times a week; 4) 3-4 times a week; 5) 5-6 times a week; 6) every day, once a day; 7) every day, 2-3 times a day; 8) every day, > 4 times a day. For the sake of the analysis, data from the short FFQ were expressed as an average serving per day for every category. For the sake of the analysis, some categories were later combined. The category “vegetables” included both fresh and cooked vegetables; the category “fruit” included both fresh fruit and natural fruit juices; the category “dairy products” included both types of cow’s milk, cheese, yoghurt/buttermilk/kefir; cottage cheese/quark; the category “wholegrains” included wholegrain bread/rye bread and groats/brown rice; the category “refined grains” included wheat bread/rolls and white rice; the category “processed meat products” included hot dogs/sausages and ham/pâté; the category “sugar sweetened beverages” included sugar-sweetened beverages and fruity drinks/flavored mineral waters.

SUBJECTIVE ASSESSMENT OF LIFESTYLE CHANGES

An additional questionnaire consisting of 15 questions focusing on perceived changes in lifestyle during the COVID-19 pandemic was administered by the interviewer. The questionnaire concerned changes in dietary habits during the pandemic, frequency of consumption of meals, snacks and chosen groups of products (vegetables and fruit, sweets, fast food, sugar-sweetened beverages). This choice resulted from the fact that consumption of these groups of products seemed to be most impacted during the pandemic [4]. Additionally, participants were asked if they started taking supplements during the pandemic. Among participants who reported starting supplementation, they were asked to state which dietary supplements they had started. The last part of the questionnaire focused on reported subjective changes in sleeping habits, physical activity and body mass.

In the case of the majority of the questions, if possible, answers were organized on a 5-point Likert scale. Depending on the question, answers ranged from “definitely decreased”, “probably decreased”, “did not change/hard to say”, “probably increased” to “definitely increased”.

ETHICS

Written and informed consent was obtained both from children and their parents/guardians. The informed consent allowed the donor to determine the scope of consent. Participants were informed that their consent could be withdrawn at any stage of the study without any consequences. The main PICTURE study was reviewed and accepted by the Bioethics Committee of Wrocław Medical University in Poland (positive opinion no. KB-667/2019). The sub-study regarding changes in dietary habits and body mass in the selected group of participants, who were examined between November 2019 and 10th March 2020,

which included the additional questionnaire, was assessed again and obtained additional approval from the Bioethics Committee of Wrocław Medical University (positive opinion no. KB-190/2022).

STATISTICAL ANALYSIS

Statistical analysis was performed using the Statistica software version 13.1. PL (StatSoft, Inc., USA). Normal distribution was verified by Kolmogorov-Smirnov test. Changes in the consumption of groups of products were assessed using the Wilcoxon matched-pairs test. Comparisons in regard to sex, age and BMI were conducted using Student’s *t*-test. For all analyses statistical significance was set at $p \leq 0.05$.

RESULTS

CHANGES IN DIETARY HABITS

The characteristics of consumption of average servings of groups of products/day before and during the pandemic are presented in Table 1.

Significant changes in consumption have been found only in the case of vegetables, fruit, sugar-sweetened beverages and poultry. Average vegetable intake decreased in the children’s group from 1.00 ± 0.75 servings/day to 0.90 ± 0.80 servings/day ($p = 0.05$). Average fruit consumption decreased from 1.70 ± 1.13 servings/day to 1.45 ± 1.08 servings/day ($p = 0.02$). Average consumption of sweetened beverages increased from 0.28 ± 0.38 servings/day to 0.44 ± 0.69 ($p = 0.01$). Average poultry consumption increased from 0.39 ± 0.25 servings/day to 0.51 ± 0.50 ($p = 0.05$).

There were no significant changes in the intake of other products. On the other hand, the average intake of some products before and after the pandemic deviated from the recommendations [14]. The average intake of dairy products was: I) 2.00 ± 1.27 servings/day, II) 2.00 ± 1.50 servings/day; The average intake of whole grain cereal products was: I) 0.90 ± 1.00 servings/day, II) 0.78 ± 0.76 servings/day. The average intake of sweets was: I) 0.95 ± 0.76 servings/day, II) 0.87 ± 0.80 servings/day. Changes in consumption between the first and the second measurement are presented in Figure 1.

At the baseline 82.4% of participants confirmed that they eat breakfast every day vs. 64.8% at the follow-up. At the baseline 85.2% of participants reported snacking between meals vs. 91.7% at the follow-up.

CHANGES IN BODY MASS

The distribution of body mass in this population did not change significantly between the measurements. At the baseline, 81.5% of children had normal body weight, 12% had overweight and 2.8% had obesity. At the follow-up, 84.3% of children had normal body weight, 9.3% had overweight and 2.8% had obesity. The characteristics of the BMI centiles in the population are presented in Table 2.

TABLE 1. Characteristics of consumption of average serving of groups of products per day at the first assessment before the pandemic in 2019-2020 (baseline) and at the second assessment in 2022 (follow-up)

	First assessment in 2019-2020 (baseline)			Second assessment in 2022 (follow-up)			Wilcoxon matched-pair test
	Total N = 108	Girls n = 59	Boys n = 49	Total N = 108	Girls n = 9	Boys n = 49	p
Vegetables [mean serving/day \pm SD]	1.00 \pm 0.75	1.08 \pm 0.70	0.93 \pm 0.80	0.90 \pm 0.80	1.05 \pm 0.90	0.75 \pm 0.70	0.05
Fruit [mean serving/day \pm SD]	1.70 \pm 1.13	1.71 \pm 1.07	1.68 \pm 1.20	1.45 \pm 1.08	1.54 \pm 1.14	1.34 \pm 0.99	0.02
Potatoes [mean serving/day \pm SD]	0.46 \pm 0.38	0.42 \pm 0.37	0.50 \pm 0.40	0.38 \pm 0.34	0.42 \pm 0.40	0.34 \pm 0.25	0.01
Dairy [mean serving/day \pm SD]	2.00 \pm 1.27	1.96 \pm 1.21	2.04 \pm 1.34	2.00 \pm 1.50	1.82 \pm 1.40	2.34 \pm 1.60	ns
Eggs [mean serving/day \pm SD]	0.39 \pm 0.34	0.38 \pm 0.38	0.39 \pm 0.29	0.39 \pm 0.35	0.33 \pm 0.25	0.50 \pm 0.42	ns
Wholegrains [mean serving/day \pm SD]	0.90 \pm 1.00	0.89 \pm 0.98	0.90 \pm 1.02	0.78 \pm 0.76	0.84 \pm 0.70	0.73 \pm 0.82	ns
Refined grains [mean serving/day \pm SD]	1.18 \pm 0.91	1.16 \pm 0.87	1.21 \pm 0.96	1.10 \pm 0.87	1.00 \pm 0.75	1.21 \pm 0.99	ns
Fish [mean serving/day \pm SD]	0.14 \pm 0.14	0.16 \pm 0.17	0.11 \pm 0.07	0.12 \pm 0.13	0.12 \pm 0.12	0.13 \pm 0.15	ns
Poultry [mean serving/day \pm SD]	0.39 \pm 0.25	0.35 \pm 0.23	0.45 \pm 0.27	0.51 \pm 0.50	0.44 \pm 0.41	0.58 \pm 0.58	0.05
Red meat [mean serving/day \pm SD]	0.17 \pm 0.15	0.17 \pm 0.16	0.17 \pm 0.13	0.18 \pm 0.28	0.15 \pm 0.16	0.22 \pm 0.36	ns
Processed meat/charcuterie [mean serving/day \pm SD]	0.88 \pm 0.78	0.77 \pm 0.72	1.04 \pm 0.83	0.81 \pm 0.75	0.56 \pm 0.48	1.16 \pm 0.87	ns
Sweets [mean serving/day \pm SD]	0.95 \pm 0.76	0.86 \pm 0.74	1.07 \pm 0.78	0.87 \pm 0.80	0.74 \pm 0.72	1.03 \pm 0.90	ns
Salty snacks [mean serving/day \pm SD]	0.29 \pm 0.43	0.27 \pm 0.36	0.32 \pm 0.50	0.32 \pm 0.48	0.28 \pm 0.35	0.40 \pm 0.60	ns
Sugar-sweetened beverages [mean serving/day \pm SD]	0.28 \pm 0.38	0.26 \pm 0.28	0.30 \pm 0.49	0.44 \pm 0.69	0.46 \pm 0.85	0.42 \pm 0.45	0.006
Mineral water natural [mean serving/day \pm SD]	2.77 \pm 1.25	2.83 \pm 1.23	2.67 \pm 1.27	2.78 \pm 1.39	2.74 \pm 1.40	2.84 \pm 1.38	ns
Fast food [mean serving/day \pm SD]	0.08 \pm 0.05	0.08 \pm 0.04	0.08 \pm 0.05	0.11 \pm 0.24	0.13 \pm 0.32	0.10 \pm 0.08	ns

SD – standard deviation, ns – non-significant. For all analyses statistical significance was set at $p \leq 0.05$.

SUBJECTIVE ASSESSMENT OF LIFESTYLE CHANGES

One fifth of children (20.4%) reported that their dietary habits changed during the pandemic. One third of participants (34.2%) reported that they ate less snacks during the pandemic, whereas 29.7% reported that they increased the frequency of snacking between meals.

The majority of participants reported that they did not change their consumption of vegetables/fruit, sweets, sugar-sweetened beverages and fast food (64.8%, 52.8%, 61.1% and 58.3%, respectively). One fifth of participants (22.2%) reported increased consumption of sweets. Only 6.5% reported decreased consumption of vegetables/fruit, whereas 11.1% reported that they increased their

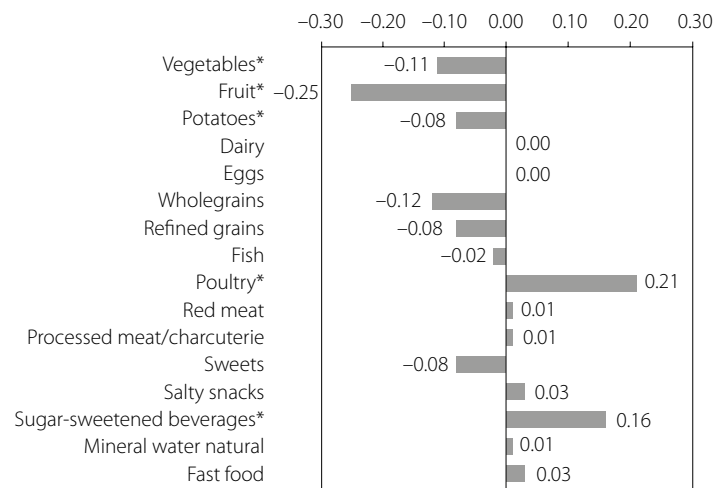


FIGURE 1. Changes in consumption between first assessment in 2019-2020 (baseline) and the 2nd assessment in 2022 (follow-up) [servings/day]

Changes in the consumption of groups of products were analyzed using Wilcoxon matched-pairs test; For all analyses the statistical significance was set at $p \leq 0.05$. Statistically significant p values are flagged with.

TABLE 2. Characteristics of age and body mass index (BMI) centiles in the study population (n = 108)

Factor	Total, N = 108	Girls, n = 59	Boys, n = 49	p-value*
Age				
M ± SD	10.60 ± 2.08	10.90 ± 2.17	10.35 ± 1.95	ns
Me [Q1; Q3]	10.50 [9.00;12.00]	11.00 [9.00; 13.00]	10.00 [9.00-12.00]	
Min-Max	7-15	7-15	7-14	
BMI centile: First assessment in 2019-2020 (Baseline)				
M ± SD	51.23 ± 26.94	51.24 ± 26.86	51.22 ± 27.33	ns
Me [Q1; Q3]	53.50 [27.50; 74.00]	53.00 [28.00; 71.00]	55.00 [27.00; 75.00]	
Min-Max	3-98	3-98	3-96	
BMI centile: Second assessment in 2022 (Follow-up)				
M ± SD	48.88 ± 27.46	50.49 ± 26.79	46.94 ± 28.40	ns
Me [Q1; Q3]	49.50 [28.00; 71.50]	53.00 [29.00; 72.00]	45.00 [22.00; 71.00]	
Min-Max	0.1-99	3-99	0.1-95	

*Student's t-test

M – mean, Me – median, Q1 – lower quartile, Q3 – upper quartile, Min – minimum, Max – maximum, SD – standard deviation, ns – non-significant

consumption during the pandemic. Almost one third of participants (31.5%) reported increased intake of supplements during the pandemic (especially vitamin D and vitamin C). A total of 35.1% of participants reported that the pandemic was the time when they tried new recipes and culinary technics.

More than half of participants did not report any changes in sleep time or sleep quality during the pandemic (56.5% and 74.1%, respectively). However, 34.3% of participants reported that their sleeping time increased, but only 14.8% reported an increase in the sleep quality.

The majority of participants (60.2% and 45.4%, respectively) reported that the time they spent sitting increased during the pandemic and their leisure physi-

cal activity decreased. 37.1% of participants felt that their body mass increased during the pandemic.

DISCUSSION

This study compared dietary habits and body mass index before and after the COVID-19 pandemic in children. The analysis revealed that dietary habits were generally constant, although consumption of vegetables and fruit significantly decreased between the two measurements and consumption of sugar-sweetened beverages significantly increased. The BMI distribution in this population was also very similar in both measurements. The discrepancy between the self-reported increase in body mass during the pandemic and lack of increase

in the actual measurement might suggest that the changes in body mass were temporary and improved after lockdowns.

The closure of schools, and as a result, disruption of daily habits, lack of access to organized sport activities and increased sedentary time were the main concern in regard to risk of obesity in children [4, 5]. It has been previously observed that increased out-of-school time, e.g. during summer school break, was associated with increased weight gain in children [15, 16]. Dietary habits were also affected by lockdowns and out-of-school time. Some mechanisms could have been potentially beneficial, e.g. lower chance of skipping meals during the day, more home-cooked meals and time to test new recipes. On the other hand, the increased chance of snacking between meals and increased consumption of nonperishable processed foods also occurred during lockdowns [7, 17, 18]. Economic consequences of COVID-19, including lower family income and job loss, also affected food security [18]. In some households low food security severely influenced the home food environment.

A study by Woolford *et al.* [19] based on Kaiser Permanente Southern California (KPSC) retrospective data, showed that children gained more weight during the COVID-19 pandemic than before the pandemic, especially children between the ages of 5 and 11. The weight gain during the pandemic was higher by approximately 2 kg than in the reference period and prevalence of overweight/obesity increased by 8.7% in this age group. Similarly, a study by Weaver *et al.* [20] showed that children's BMI z-score change was on average 10 times greater during the pandemic than in the reference period. In another study, in which weight gain during the pandemic was also observed, it was pointed out that this effect was especially visible in groups already more vulnerable to excess weight gain [21]. Children with pre-existing obesity experienced the biggest increase in body mass in comparison to pre-pandemic rates [21, 22]. Although weight gain was especially noticeable in the first three months of the pandemic (and strictest lockdown), a tendency of increasing BMI and BMI z-scores was observed for 1 year into the pandemic [23]. In a study conducted in Germany, parents reported excess body weight gain during the pandemic in 32% of 10-12-year-old children [17]. In this study the majority of parents reported that dietary habits of children did not change, but in 16% dietary habits worsened (higher consumption of sweets, fast food, sugar-sweetened beverages and frequent snacking), which is in line with our results. In our study, the majority of children reported decreased physical activity and increased sedentary time. Similarly, in a study by Weihrauch-Blüher *et al.* [17] reduction in physical activity reported by parents was the most prevalent among 10-12-year-olds in comparison to other age groups (57% reported reduction in physical activity). In the same study, 70% of children increased media consumption in their leisure time.

Proper dietary habits are crucial not only to ensure overall health and development of a child, but they also shape their future susceptibility to noncommunicable diseases. In our cohort, consumption of the first breakfast decreased by 17% between baseline and follow-up. It is not a favorable tendency, since breakfast consumption has been associated with better cognitive functioning during the day [24] and lower risk of obesity [25]. In a study conducted in the same region it was previously found that likelihood of consuming breakfast decreased with age of adolescents [26].

Results from studies investigating changes of dietary patterns during the pandemic are inconclusive and do not show a consistent pattern. In a study conducted in populations from Spain, Brazil, Chile, Colombia and Italy, consumption of vegetables, fruit, and legumes increased during COVID lockdown [27]. In the same study, frequency of consumption of fried foods and sweets increased. Consumption of sugar-sweetened beverages did not change [27]. Similarly to our results, in a study by Adams *et al.* [18] over 30% of participants reported increased consumption of sweets and desserts, as well as nonperishable processed foods, during the pandemic. At this time, preparing meals at home was more popular than take out. In a small study by Pietrobelli *et al.* [28] conducted in Italy, intake of potato chips, red meat, and sugar-sweetened beverages increased significantly during the lockdown. However, there was no change in consumption of vegetables and even a slight increase in fruit consumption. Similarly, a study by Munasinghe *et al.* [29] showed no changes in vegetables or fruit consumption during the pandemic. A study by Koletzko *et al.* [30] reported an increase in vegetables and fruit in school-aged children during the pandemic (in 14% and 20% respectively), but a concomitant increase in consumption of sweets, soft drinks and salty snacks (in 20%, 18% and 18% respectively).

Interestingly, in our study, changes in dietary habits were not significant except for several groups of products and even then the observed changes were small, but it is evident that some dietary choices were far from recommendations both before and after pandemic restrictions. At both time points consumption of vegetables, wholegrains, dairy products, and fish was lower than recommended. On the other hand, processed meat products and sweets were consumed much more frequently (on average almost 1 serving/day). This tendency is consistent with results obtained for adolescents in Wrocław several years prior to this study [26]. Insufficient consumption of vegetables can be associated with lower intake of dietary fiber, vitamins from the B group and flavonoids. Milk and dairy products are a rich source of calcium, phosphorus, zinc, magnesium, and vitamins D and K, which are important for bone formation and skeletal development in adolescents [31]. Our study group had a tendency to eat more processed meat products

than unprocessed meat and poultry. Processed meat products should be eaten only occasionally. The International Agency for Research on Cancer (IARC) classified processed meat products in group 1, which comprises known carcinogenic substances [32]. Increased snacking and higher consumption of sugar-sweetened beverages are also potentially obesogenic behaviors. Although in the present study we did not observe a significant increase in overweight and obesity in our study group, dietary habits should be monitored and improved by educational programs. The revealed tendencies could potentially contribute to excessive body mass in the future, as well as to development of noncommunicable diseases [5, 33].

There are some limitations to consider. Showing changes in consumption between boys and girls and in different age groups was hindered by the limited number of participants. On the other hand, the small study group resulted from availability of baseline data before the COVID-19 outbreak. Moreover, there were no statistically significant differences between sexes. Long-term effects and consistency of lifestyle habits require further investigation in the whole PICTURE study group.

CONCLUSIONS

Between the first assessment before the pandemic and the second assessment two years after, dietary habits changed only slightly in the study group, but vegetable and fruit consumption among children and adolescents declined, while consumption of poultry and sweetened beverages increased. The prevalence of overweight and obesity did not significantly change during the analyzed period. The revealed tendencies in dietary habits could potentially contribute to excessive body mass in the future; therefore it is important to target nutrition in educational programs.

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CONFLICTS OF INTEREST

The authors declare no conflict of interest.

References

1. Wang G, Zhang Y, Zhao J, et al. Mitigate the effects of home confinement on children during the COVID-19 outbreak. *Lancet* 2020; 395(10228): 945-947. DOI: 10.1016/S0140-6736(20)30547-X.
2. Gujski M, Raciborski F, Jankowski M, et al. Epidemiological analysis of the first 1389 cases of COVID-19 in Poland: a preliminary report. *Med Sci Monit* 2020; 26: e924702. DOI: 10.12659/MSM.924702.
3. Gruszczynski L, Zatoński M, McKee M. Do regulations matter in fighting the COVID-19 pandemic? Lessons from Poland. *Eur J Risk Regul* 2021; 12: 739-757.
4. Stavridou A, Kapsali E, Panagouli E, et al. Obesity in children and adolescents during COVID-19 pandemic. *Children (Basel)* 2021; 8(2): 135. DOI: 10.3390/CHILDREN8020135.
5. OECD/European Union. Health at a Glance: Europe 2022. State of health in the EU cycle. Available from: https://www.oecd-ilibrary.org/social-issues-migration-health/health-at-a-glance-europe-2022_507433b0-en (accessed: 20 November 2023).
6. Akter T, Zeba Z, Hosen I, et al. Impact of the COVID-19 pandemic on BMI: Its changes in relation to socio-demographic and physical activity patterns based on a short period. *PLoS One* 2022; 17(3): e0266024. DOI: 10.1371/journal.pone.0266024.
7. Sidor A, Rzymiski P. Dietary choices and habits during COVID-19 lockdown: experience from Poland. *Nutrients* 2020; 12(6): 1657. DOI: 10.3390/nu12061657.
8. World Health Organization, Regional Office for Europe. Adolescent obesity and related behaviours: trends and inequalities in the WHO European Region; 2002–2014: observations from the Health Behaviour in School-aged Children (HBSC) WHO collaborative cross-national study. World Health Organization, 2017. Available from: <https://www.who.int/europe/publications/i/item/9789289052405> (accessed: 10 November 2023).
9. Mazur J, Małkowska-Szkatnik A. Zdrowie uczniów w 2018 roku na tle nowego modelu badań HBSC [Student health in 2018 against the background of the new HBSC research model]. Instytut Matki i Dziecka, Warszawa 2018.
10. Zatońska K, Basiak-Rasała A, Matera-Witkiewicz A, et al. Population Cohort Study of Wrocław Citizens (PICTURE) – study protocol. *J Health Inequal* 2022; 8(1): 37-43.
11. Kułaga Z, Litwin M, Tkaczyk M, et al. Polish 2010 growth references for school-aged children and adolescents. *Eur J Pediatr* 2011; 170(5): 599-609.
12. Pazdro-Zastawny K, Kolator M, Basiak-Rasała A, et al. How to encourage children to live healthy lives? A prophylactic and health-oriented campaign called “Let’s Get the Kids Moving” aimed at children in Wrocław schools. *J Health Inequal* 2019; 5(2): 188-191.
13. Teo K, Chow CK, Vaz M, et al.; PURE Investigators-Writing Group. The Prospective Urban Rural Epidemiology (PURE)

- study: examining the impact of societal influences on chronic noncommunicable diseases in low-, middle-, and high-income countries. *Am Heart J* 2009; 158: 1-7.e1. DOI: 10.1016/j.ahj.2009.04.019.
14. Jarosz M, Rychlik E, Stoś K, et al. Normy żywienia dla populacji Polski i ich zastosowanie [Dietary recommendations for Polish population and their implementation]. Narodowy Instytut Zdrowia Publicznego – Państwowy Zakład Higieny, Warszawa 2020. Available from: https://www.pzh.gov.pl/wp-content/uploads/2020/12/Normy_zywienia_2020web-1.pdf (accessed: 10 November 2023).
 15. Franckle R, Adler R, Davison K. Accelerated weight gain among children during summer versus school year and related racial/ethnic disparities: a systematic review. *Prev Chronic Dis* 2014; 11: E101. DOI: 10.5888/PCD11.130355.
 16. von Hippel PT, Workman J. From kindergarten through second grade, U.S. children's obesity prevalence grows only during summer vacations. *Obesity (Silver Spring)* 2016; 24(11): 2296-2300.
 17. Weihrauch-Blüher S, Huizinga O, Joisten C, et al. Changes in lifestyle and body weight in children and adolescents during the COVID-19 pandemic: a representative survey of parents in Germany. *Obes Facts* 2023; 16(3): 301-312.
 18. Adams EL, Caccavale LJ, Smith D, Bean MK. Food insecurity, the home food environment, and parent feeding practices in the era of COVID-19. *Obesity (Silver Spring)* 2020; 28(11): 2056-2063.
 19. Woolford SJ, Sidell M, Li X, et al. Changes in body mass index among children and adolescents during the COVID-19 pandemic. *JAMA* 2021; 326(14): 1434-1436.
 20. Weaver RG, Hunt ET, Armstrong B, et al. COVID-19 leads to accelerated increases in children's BMI z-score gain: an interrupted time-series study. *Am J Prev Med* 2021; 61(4): e161-e169. DOI: 10.1016/j.amepre.2021.04.007.
 21. Brooks CG, Spencer JR, Sprafka JM, et al. Pediatric BMI changes during COVID-19 pandemic: an electronic health record-based retrospective cohort study. *EClinicalMedicine* 2021; 38: 101026. DOI: 10.1016/j.eclinm.2021.101026.
 22. Knapp EA, Dong Y, Dunlop AL, et al. Changes in BMI during the COVID-19 pandemic. *Pediatrics* 2022; 150(3): e2022056552. DOI: 10.1542/PEDS.2022-056552.
 23. Gwag SH, Oh YR, Ha JW, et al. Weight changes of children in 1 year during COVID-19 pandemic. *J Pediatr Endocrinol Metab* 2021; 35(3): 297-302.
 24. Cooper SB, Bandelow S, Nevill ME. Breakfast consumption and cognitive function in adolescent schoolchildren. *Physiol Behav* 2011; 103(5): 431-439.
 25. Timlin MT, Pereira MA, Story M, et al. Breakfast eating and weight change in a 5-year prospective analysis of adolescents: project EAT (Eating Among Teens). *Pediatrics* 2008; 121(3): e638-645. DOI: 10.1542/peds.2007-1035.
 26. Basiak-Rasała A, Górna S, Krajewska J, et al. Nutritional habits according to age and BMI of 6-17-year-old children from the urban municipality in Poland. *J Health Popul Nutr* 2022; 41(1): 17. DOI: 10.1186/s41043-022-00296-9.
 27. Ruiz-Roso MB, Padilha P, Mantilla-Escalante DC, et al. Covid-19 confinement and changes of adolescent's dietary trends in Italy, Spain, Chile, Colombia and Brazil. *Nutrients* 2020; 12(6): 1807. DOI: 10.3390/NU12061807.
 28. Pietrobello A, Pecoraro L, Ferruzzi A, et al. Effects of COVID-19 lockdown on lifestyle behaviors in children with obesity living in Verona, Italy: a longitudinal study. *Obesity (Silver Spring)* 2020; 28(8): 1382-1385.
 29. Munasinghe S, Sperandei S, Freebairn L, et al. The impact of physical distancing policies during the COVID-19 pandemic on health and well-being among Australian adolescents. *J Adolesc Health* 2020; 67(5): 653-661.
 30. Koletzko B, Holzapfel C, Schneider U, Hauner H. Lifestyle and body weight consequences of the COVID-19 pandemic in children: increasing disparity. *Ann Nutr Metab* 2021; 77(1): 1-3.
 31. Rizzoli R. Dairy products, yogurts, and bone health. *Am J Clin Nutr* 2014; 99(5 Suppl): 1256S-1262S.
 32. Bouvard V, Loomis D, Guyton KZ, et al. Carcinogenicity of consumption of red and processed meat. *Lancet Oncol* 2015; 16(6): 1599-1600.
 33. Meier T, Gräfe K, Senn F, et al. Cardiovascular mortality attributable to dietary risk factors in 51 countries in the WHO European Region from 1990 to 2016: a systematic analysis of the Global Burden of Disease Study. *Eur J Epidemiol* 2019; 34(1): 37-55.

AUTHORS' CONTRIBUTIONS

ABR, KPZ, KZ took part in preparing the concept of the article, collected and analyzed data, prepared the first draft of the article and worked on the final version. ABR, KPZ – did literature search, contributed to drafting the manuscript and revising it. AMW collected data. AMW, KKP, DGD, KZ, TZ revised the manuscript. All authors took part in preparation of the final version of the manuscript.