Use of Mobile Apps and Wearables to Monitor Diet, Weight, and Physical Activity: A Cross-Sectional Survey of Adults in Poland

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Background: Mobile health technologies (mHealth) such as mobile applications (mobile apps), and wearables are gaining popularity. Regular monitoring of public attitudes toward the use of mHealth is crucial to effectively implementing mHealth in healthcare. Therefore, this study aimed to assess the level of use of mobile apps and wearables to monitor diet, weight, and physical activity among adults in Poland and to identify factors associated with the willingness to use new technologies for health monitoring.

Material/Methods: This cross-sectional survey was carried out on a representative sample of 1070 adult inhabitants of Poland, between 1 and 4 July, 2022. A computer-assisted web interview (CAWI) technique was used. The study questionnaire included 20 closed questions on eating habits, lifestyle, and the use of eHealth mobile apps and wearables.

Results: Almost one-quarter of respondents (23.2%) used wearables (a band or a watch) to monitor physical activity and 14.4% had a smart bathroom scale at home. Among adults in Poland, 16.3% used mobile apps to monitor physical activity and 13.3% used mobile apps to control their diet. Out of 19 different socioeconomic and lifestyle factors analyzed in this study, younger age, healthy diet, regular physical activity, and participation in organized sports activities were significantly associated (P<0.05) with the use of mobile apps and wearables.

Conclusions: A lack of socioeconomic barriers to accessing mobile apps and wearables presented in this study suggests that mHealth technology can be used to promote a healthy lifestyle in different socioeconomic groups and can reduce health inequalities.

Keywords: Body Weights and Measures • Fitness Trackers • Food Habits • Health Promotion • Internet of Things • Mobile Applications • Poland • Telemedicine

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Background

Chronic non-communicable diseases (NCDs) are the leading cause of death globally [1,2]. It is estimated that NCDs kill over 40 million people each year [3]. Cardiovascular diseases, cancers, and respiratory diseases account for most of the NCDs deaths [3]. Most of the NCDs are the results of modifiable behavioral risk factors [1-3]. Physical inactivity, unhealthy diet, and substance use (tobacco/alcohol) are the major risk factors contributing to NCDs [3,4]. Findings from the Global Burden of Disease Study showed that in 2019 approximately 8 million deaths were attributable to dietary risk factors [5]. The Lancet Physical Activity Series Working Group showed that physical inactivity causes 9% of premature mortality worldwide [6]. In 2013, 6% of the global burden of coronary heart diseases, 7% of type 2 diabetes, and 10% of breast cancer were attributable to physical inactivity [6]. Physical inactivity is responsible for a markable economic burden, with $53.8 billion USD in healthcare systems expenditures and $13.7 billion USD in productivity losses [7].

Due to the markable global burden of lifestyle-related NCDs, numerous NCDs prevention programs were implemented [8-10]. In 2004, the World Health Organization (WHO) adopted the “Global Strategy on Diet, Physical Activity and Health”, which aimed to promote and protect health through healthy eating and physical activity [8]. In the global strategies, numerous countries have implemented national policies on physical activity and a healthy diet. School-based physical education and infrastructural policies are considered one of the most effective policies to promote physical activity [9]. Moreover, national food-based dietary guidelines, food systems, agricultural policies, educational campaigns, and nutrition education programs were implemented to promote healthy dietary practices [10,11].

Despite the widespread actions on a healthy diet and physical activity promotion, the global prevalence of lifestyle-related risk factors remains high [12]. In recent years, mobile health technologies (mHealth) such as mobile applications (mobile apps), web-based technologies, telecommunication services, and wearable technology have been gaining popularity [13,14]. It is believed that the implementation of digital health interventions may improve disease prevention, but randomized controlled trials are still ongoing [15,16]. In 2022, more than 80% of the world’s population used a smartphone [17] and over 60% had Internet access [18]. Mobile apps are one of the most popular mHealth services [19,20]. In 2022, there were more than 52 000 different healthcare and medical apps available on the Google Play Store and more than 51 000 available on the Apple App Store [19,20]. Mobile apps to control diet and physical activity are one of the most popular digital health tools that support users in their lifestyle improvement [14,19,20].

Nutrition-related mobile apps influence consumers’ healthy food behavior and dietary intake with web-based food recalls, provide personalized health tips, and allow them to set individual goals to increase motivation and track changes in dietary behaviors [21]. Mobile apps also deliver accessible and appealing physical activity interventions that effectively increase physical activity [22]. A growing number of mobile apps are designed and dedicated to patients with chronic diseases [23].

Another group of technologies that is widely implemented in healthcare is Internet of Things (IoT) technology, which allows for collecting, monitoring, managing, and analyzing data from sensors [24]. One of the most popular applications of IoT are wearable devices with sensors placed on the body that collect data (eg, on daily habits, physical activity, and hydration) [25]. The most popular mHealth wearables are wristbands or smartwatches that can monitor an individual’s activities in an accessible way [24,25].

The global mobile medical apps and wearables market is growing rapidly [19,20]. However, the implementation of mHealth varies across countries [26]. Public acceptance of mHealth services is necessary for the effective adoption mHealth interventions. Poland is an example of a European Union (EU) country with a relatively high level of use of information and communications technology (ICT) in the healthcare system [27]. However, there is a lack of nationally representative data on public attitudes toward the use of mHealth services such as mobile apps and wearables among adults in Poland. Mobile apps and wearables can significantly increase the effectiveness of health policies and preventive programs on NCDs. Regular monitoring of public attitudes toward the use of mHealth services is crucial to provide public health interventions on lifestyle changes that will be based on mobile health technologies.

Therefore, this study aimed to assess the level of use of mobile apps and wearables to monitor diet, weight, and physical activity among adults in Poland and to identify factors associated with willingness to use new technologies for health monitoring.

Material and Methods

Ethics

The study protocol was reviewed and approved by the Ethical Board at the Medical University of Warsaw, Poland (no. AKBE/176/2022). Participation in the study was voluntary and anonymous. Informed consent was obtained by the Nationwide Research Panel Ariadna on recruitment of respondents.
Study Design and Participants

This cross-sectional survey was carried out among adult inhabitants of Poland, between 1 and 4 July, 2022. Data were collected by a specialized and certified survey company (the Nationwide Research Panel Ariadna) on behalf of the authors, who provided the scientific context of this study [28]. A computer-assisted web interview (CAWI) technique was used. Respondents filled the questionnaire through the dedicated IT system managed by the survey company. A representative sample of the adult Polish population was selected from more than 100,000 registered and verified individual users of the survey company web platform [28]. A non-probability quota sampling technique was used. The stratification model included gender, age, and place of residence (size of the city and location) and was based on the nationwide demographic data provided by the Central Statistical Office, Warsaw, Poland.

As this study aimed to assess the level of use of mobile apps and wearables to monitor diet, weight, and physical activity in a representative sample of adults, a dedicated survey company was contracted to collect the data. Due to technical reasons and a lack of databases that provide representativeness of the population, the authors were not able to collect data on their own. Similar methods were used in previously published studies on tobacco use [29] and vaccine hesitancy in Poland [30].

Study Questionnaire and Measures

The study questionnaire included 20 closed questions on eating habits, diet-related non-communicable diseases, the use of eHealth mobile apps and smart devices, lifestyle, and sociodemographic characteristics. The questionnaire was self-prepared by the authors and based on previously published studies on mobile health technology use as well as market research on the top consumer mHealth services/devices available in Poland [13-15].

The Use of Mobile Apps

Respondents were asked about their attitudes toward the use of mobile apps, using the following question: “Have you used any of the following weight management and/or physical activity methods in the last 12 months? (1) mobile app on the phone or tablet to monitor physical activity level (eg, Endomondo); (2) mobile app on the phone or tablet to control the diet (eg, counting calories, checking the calorific value of meals or recipes for meals)” with 2 possible answers: “Yes” or “No”.

The Use of Wearables and Internet of Things Technology

Respondents were asked about their attitudes toward the use of wearables and the Internet of Things technology, using the following question: “Have you used any of the following technologies in the last 12 months: (1) a band or a watch to monitor physical activity level (eg, FitBit, Xiaomi Mi Band, Garmin) in the last 12 months; (2) smart bathroom scale with a mobile application that, in addition to body weight, allows you to assess select parameters of the body composition (eg, the level of adipose tissue, muscle tissue)” with 2 possible answers: “Yes” or “No”.

Moreover, respondents were asked about their diet, regular weight control physical activity level, gym/fitness club passes, and participation in organized/group sports activities. Questions on tobacco use and alcohol consumption were also addressed.

Data Analysis

The raw datasets received from the survey company were analyzed by the authors with SPSS v. 28 (IBM Corp., Armonk, NY, USA). The distribution of categorical variables was shown by frequencies and proportions. Cross-tabulations and chi-squared tests were used to compare categorical variables.

Associations between sociodemographic/lifestyle factors and the use of mobile apps and wearables to monitor diet were analyzed using logistic regression analyses. The use of (1) mobile apps to monitor physical activity; (2) mobile apps to control the diet; (3) band or watch to monitor physical activity; and (4) smart bathroom scale was considered separately as dependent variables in the model. Nineteen different sociodemographic/lifestyle factors were considered independent variables. In simple logistic regression analyses, all variables were considered separately. Multivariable logistic regression models included all significantly significant variables identified in simple regression analyses. The strength of association was presented with an odds ratio (OR) and 95% confidence intervals (95% CI). Statistical inference was based on the criterion P<0.05.

Results

Characteristics of the Study Population

Data were received from 1070 individuals; 52.6% were females and the mean age of respondents was 45.1±16.1 years (Table 1). Most of the participants were married (50.5%), 43.4% had higher education, and almost two-thirds had children (63.3%) and were currently employed/self-employed (62.2%). Among the participants, 45% had at least 1 chronic disease. More than one-quarter of the respondents (28.7%) did not take a regular check-up by healthcare professionals, and 7.5% declared both weight self-control and check-ups by the healthcare professionals (Table 1). Almost one-fifth of respondents (18.4%) did not eat three meals a day at regular intervals, which is considered unsafe dietary habits. About one-fifth of respondents (22.2%) did not typically follow a diet (Table 1).
Table 1. Characteristics of the study population (n=1070).

| Variable                          | n   | %    |
|-----------------------------------|-----|------|
| **Gender**                        |     |      |
| Female                            | 570 | 53.3 |
| Male                              | 500 | 46.7 |
| **Age (years)**                   |     |      |
| 18-29                             | 236 | 22.1 |
| 30-39                             | 214 | 20.0 |
| 40-49                             | 182 | 17.0 |
| 50-59                             | 190 | 17.8 |
| 60+                               | 248 | 23.2 |
| **Educational level**             |     |      |
| Primary                           | 24  | 2.2  |
| Vocational                        | 107 | 10.0 |
| Secondary                         | 475 | 44.4 |
| Higher                            | 464 | 43.4 |
| **Marital status**                |     |      |
| Single                            | 229 | 21.4 |
| Married                           | 540 | 50.5 |
| Informal relationship             | 174 | 16.3 |
| Divorced                          | 43  | 4.0  |
| Widowed                           | 84  | 7.9  |
| **Having children**               |     |      |
| Yes                               | 677 | 63.3 |
| No                                | 393 | 36.7 |
| **Number of household members**   |     |      |
| Living alone                      | 147 | 13.7 |
| Living with at least one person   | 923 | 86.3 |
| **Children under 18 years in home** |     |      |
| Yes                               | 372 | 34.8 |
| No                                | 698 | 65.2 |
| **Place of residence**            |     |      |
| Rural                             | 357 | 33.4 |
| City below 20,000 residents       | 135 | 12.6 |
| City from 20,000 to 99,999 residents | 227 | 21.2 |
| City from 100,000 to 499,999 residents | 202 | 18.9 |
| City above 500,000 residents      | 149 | 13.9 |
| **Occupational status**           |     |      |
| Active                            | 666 | 62.2 |
| Passive                           | 404 | 37.8 |
| **Self-reported economic status** |     |      |
| Rather good, good or very good    | 410 | 38.3 |
| Moderate/difficult to tell        | 430 | 40.2 |
| Rather bad, bad or very good      | 230 | 21.5 |
| **Presence of chronic diseases**  |     |      |
| Yes                               | 481 | 45.0 |
| No                                | 589 | 55.0 |
| **Self-reported health status**   |     |      |
| Rather good, good or very good    | 472 | 44.1 |
| Moderate/difficult to tell        | 502 | 46.9 |
| Rather bad, bad or very good      | 96  | 9.0  |
| **Having diet**                   |     |      |
| Yes                               | 307 | 28.7 |
| No                                | 763 | 71.3 |
| **Regular weight control**        |     |      |
| Yes, self-control                 | 523 | 48.9 |
| Yes, a regular check-up by the healthcare professional | 23 | 2.1 |
| Yes, both self-control and check-up by the healthcare professional | 80 | 7.5 |
| No                                | 444 | 41.5 |
| **Physical activity**             |     |      |
| Everyday                          | 176 | 16.4 |
| 3-4 Times per week                | 193 | 18.0 |
| 1-2 Times per week                | 220 | 20.6 |
| 2-3 Times per month               | 98  | 9.2  |
| Once per month                    | 43  | 4.0  |
| Less than once per month          | 143 | 13.4 |
| Never                             | 197 | 18.4 |
| **Tobacco use**                   |     |      |
| Daily smoker                      | 256 | 23.9 |
| Occasional smoker                 | 86  | 8.0  |
| Non-smokers                       | 728 | 68.0 |
not undertake any physical activity. Approximately one-tenth had a gym/fitness club pass (11.2%) or declared participation in organized/group sports activities (10.8%). Among the respondents, 23.9% were daily smokers and 4.8% consumed alcohol every day (Table 1).

### The Use of Mobile Apps and Wearables to Control Diet, Weight, and Physical Activity

Almost one-quarter of respondents (23.2%) used wearables (a band or a watch) to monitor physical activity and 14.4% had a smart bathroom scale at home (Table 2). Among adults in Poland, 16.3% used mobile apps to monitor physical activity and 13.3% used mobile apps to control their diet. Younger respondents (age 18-39 years), those who were single or in an informal relationship, respondents who do not have children, and currently employed/self-employed individuals more often (P<0.05) used mobile apps to control diet, weight, and physical activity (Table 2). Moreover, respondents with good health status, those who lived in cities population 20 000-99 999 residents or the biggest cities above 500 000 residents more often declared the use of mobile apps to monitor physical activity (P<0.05).

There were no statistically significant differences in the prevalence of use of mobile apps and wearables/smart devices by gender, educational level, and tobacco use (Table 2). Respondents who followed a diet, those who declared regular weight control, those with regular physical activity, and respondents who had gym/fitness club passes or attended organized/group sports activities more often declared (P<0.05) the use of mobile apps and wearables/IoT technology to control diet, weight, and physical activity (Table 2).

### Factors Associated with the Use of Mobile Apps

In multivariable logistic regression analyses (Table 3), age 18-29 (OR: 3.77; 95% CI: 1.84-7.75; p<0.001) or 30-39 years (OR: 2.57; 95% CI: 1.26-5.24; p=0.01), living in cities from 20 000 to 99 999 residents (OR: 1.92; 95% CI: 1.17-3.16; P=0.01) or above 500 000 residents (OR: 2.14; 95% CI: 1.22-3.74; P=0.008), following a diet (OR: 1.54; 95% CI: 1.04-2.28; p=0.03), regular weight control (OR: 1.76; 95% CI: 1.16-2.67; P=0.008), at least minimal physical activity (p<0.05), occasional alcohol consumption (P<0.05) and participation in organized/groups sports activities (OR: 1.70; 95% CI: 1.04-2.76; P=0.03) were significantly associated with higher odds of use mobile apps to monitor physical activity level (Table 3). Age 18-49 years (P<0.05), following a diet (OR: 2.71; 95% CI: 1.77-4.14; P<0.001), regular weight control (OR: 2.19; 95% CI: 1.36-3.53; P<0.001), alcohol consumption 2-3 times per month (OR: 2.25; 95% CI: 1.14-5.58; P=0.02), having gym/fitness club passes (OR: 1.94; 95% CI: 1.16-3.23; P=0.01), and participation in organized/groups sports activities (OR: 2.29; 95% CI: 1.36-3.87; P=0.002) were significantly associated with higher odds of use mobile apps to control the diet (Table 3).

### Factors Associated with the Use of Wearables and Internet of Things Technology

In multivariable logistic regression analyses (Table 4), age 18-29 years (OR: 2.60; 95% CI: 1.53-4.39; P<0.001), good financial status (OR: 1.63; 95% CI: 1.07-2.54; P=0.03), regular weight control (OR: 1.54; 95% CI: 1.10-2.16; P=0.01), daily physical activity (OR: 2.28; 95% CI: 1.27-4.09; P=0.006) or physical activity for 3-4 times per week (OR: 1.90; 95% CI: 1.05-3.42; p=0.03), and participation in organized/groups sports activities (OR: 1.79; 95% CI: 1.15-2.80; P=0.01) were significantly associated with higher odds of use wearables to monitor physical activity (Table 4). Out of 19 different factors analyzed in this study, regular weight control (OR: 3.15; 95% CI: 1.96-5.06; P<0.001), daily physical activity (OR: 3.91; 95% CI: 1.77-8.66; P<0.001) or physical activity 3-4 times per week (OR: 4.17; 95% CI: 1.88-9.29; P<0.001) and daily alcohol consumption (OR: 3.40; 95% CI: 1.41-8.24; P=0.007) were significantly associated with higher odds of use of a smart bathroom scale (Table 4).

#### Table 1 continued. Characteristics of the study population (n=1070).

| Variable                              | n    | %    |
|---------------------------------------|------|------|
| Alcohol consumption                   |      |      |
| Everyday                              | 51   | 4.8  |
| 3-4 Times per week                    | 110  | 10.3 |
| 1-2 Times per week                    | 235  | 22.0 |
| 2-3 Times per month                   | 186  | 17.4 |
| Once per month                        | 116  | 10.8 |
| Less than once per month              | 215  | 20.1 |
| Never                                 | 157  | 14.7 |

#### Table 2

| Variable                              | n    | %    |
|---------------------------------------|------|------|
| Having gym/fitness club passes        |      |      |
| Yes                                   | 120  | 11.2 |
| No                                    | 950  | 88.8 |
| Participation in organized/group sports activities |
| Yes                                   | 116  | 10.8 |
| No                                    | 954  | 89.2 |
Table 2. Respondents’ attitudes towards the use of mHealth technologies to control diet, weight, and physical activity (n=1070).

| Variable                        | Mobile application to monitor physical activity | Mobile application to control the diet | A band or a watch to monitor physical activity | Smart bathroom scale |
|---------------------------------|-----------------------------------------------|--------------------------------------|-----------------------------------------------|----------------------|
|                                 | n (%)  | p     | n (%)  | p     | n (%)  | p     | n (%)  | p     |
| Overall                         | 174 (16.3) | 142 (13.3) | 248 (23.2) | 154 (14.4) |
| Gender                          |        |       |        |       |        |       |        |       |
| Female                          | 90 (15.8) | 0.7   | 84 (14.7) | 0.1   | 136 (23.9) | 0.6   | 78 (13.7) | 0.5   |
| Male                            | 84 (16.8) | 58 (11.6) | 112 (22.4) | 76 (15.2) |
| Age (years)                     |        |       |        |       |        |       |        |       |
| 18-29                           | 66 (28.0) | <0.001 | 59 (25.0) | <0.001 | 77 (32.6) | <0.001 | 36 (15.3) | 0.7   |
| 30-39                           | 45 (21.0) | 38 (17.8) | 57 (26.6) | 36 (16.8) |
| 40-49                           | 22 (12.1) | 23 (12.6) | 40 (22.0) | 22 (12.1) |
| 50-59                           | 20 (10.5) | 13 (6.8)   | 42 (22.1) | 27 (14.2) |
| 60+                             | 21 (8.5)   | 9 (3.6)   | 32 (12.9) | 33 (13.3) |
| Educational level               |        |       |        |       |        |       |        |       |
| Primary                         | 4 (16.7) | 0.1   | 2 (8.3)  | 0.7   | 3 (12.5) | 0.4   | 3 (12.5) | 0.08  |
| Vocational                      | 11 (10.3) | 11 (10.3) | 20 (18.7) | 7 (6.5)  |
| Secondary                       | 72 (15.2) | 64 (13.5) | 113 (23.8) | 77 (16.2) |
| Higher                          | 87 (18.8) | 65 (14.0) | 112 (24.1) | 67 (14.4) |
| Marital status                  |        |       |        |       |        |       |        |       |
| Single                          | 47 (20.5) | 0.006 | 38 (16.6) | 0.002 | 48 (21.0) | 0.6   | 32 (14.0) | 0.4   |
| Married                         | 70 (13.0) | 63 (11.7) | 123 (22.8) | 77 (14.3) |
| Informal relationship           | 40 (23.0) | 34 (19.5) | 48 (27.6) | 32 (18.4) |
| Divorced                        | 7 (16.3)   | 1 (2.3)   | 9 (20.9)   | 5 (11.6)   |
| Widowed                         | 10 (11.9) | 6 (7.1)   | 20 (23.8) | 8 (9.5)   |
| Having children                 |        |       |        |       |        |       |        |       |
| Yes                             | 90 (13.3) | <0.001 | 70 (10.3) | <0.001 | 153 (22.6) | 0.6   | 94 (13.9) | 0.5   |
| No                              | 84 (21.4) | 72 (18.3) | 95 (24.2) | 60 (15.3) |
| Number of household members     |        |       |        |       |        |       |        |       |
| Living alone                    | 24 (16.3) | 0.9   | 18 (12.2) | 0.7   | 24 (16.3) | 0.03  | 20 (13.6) | 0.8   |
| Living with at least one person | 150 (16.3) | 124 (13.4) | 224 (24.3) | 134 (14.5) |
| Children under 18 years in home |        |       |        |       |        |       |        |       |
| Yes                             | 62 (16.7) | 0.8   | 60 (16.1) | 0.04  | 109 (29.3) | <0.001 | 55 (14.8) | 0.8   |
| No                              | 112 (16.0) | 82 (11.7) | 139 (19.9) | 99 (14.2) |
Table 2 continued. Respondents’ attitudes towards the use of mHealth technologies to control diet, weight, and physical activity (n=1070).

| Variable | Mobile application to monitor physical activity | Mobile application to control the diet | A band or a watch to monitor physical activity | Smart bathroom scale |
|----------|-----------------------------------------------|--------------------------------------|-----------------------------------------------|---------------------|
| Place of residence | | | | |
| Rural | 46 (12.9) | 45 (12.6) | 83 (23.2) | 49 (13.7) |
| City below 20,000 residents | 16 (11.9) | 15 (11.1) | 32 (23.7) | 19 (14.1) |
| City from 20,000 to 99,999 residents | 46 (20.3) | 34 (15.0) | 57 (25.1) | 33 (14.5) |
| City from 100,000 to 499,999 residents | 34 (16.8) | 28 (13.9) | 49 (24.3) | 33 (16.3) |
| City above 500,000 residents | 32 (21.5) | 20 (13.4) | 27 (18.1) | 20 (13.4) |
| Occupational status | | | | |
| Active | 128 (19.2) | 103 (15.5) | 180 (27.0) | 100 (15.0) |
| Passive | 46 (11.4) | 39 (9.7) | 68 (16.8) | 54 (13.4) |
| Self-reported economic status | | | | |
| Rather good, good or very good | 78 (19.0) | 65 (15.9) | 116 (28.3) | 59 (14.4) |
| Moderate/difficult to tell | 61 (14.2) | 48 (11.2) | 92 (21.4) | 59 (13.7) |
| Rather bad, bad or very good | 35 (15.2) | 29 (12.6) | 40 (17.4) | 36 (15.7) |
| Presence of chronic diseases | | | | |
| Yes | 62 (12.9) | 57 (11.9) | 109 (22.7) | 81 (16.8) |
| No | 112 (19.0) | 85 (14.4) | 139 (23.6) | 73 (12.4) |
| Self-reported health status | | | | |
| Rather good, good or very good | 97 (20.6) | 75 (15.9) | 117 (24.8) | 69 (14.6) |
| Moderate/difficult to tell | 62 (12.4) | 54 (10.8) | 107 (21.3) | 67 (13.3) |
| Rather bad, bad or very good | 15 (15.6) | 13 (13.5) | 24 (25.0) | 18 (18.8) |
| Having diet | | | | |
| Yes | 71 (23.1) | 71 (23.1) | 89 (29.0) | 65 (21.2) |
| No | 103 (13.5) | 71 (9.3) | 159 (20.8) | 89 (11.7) |
| Regular weight control | | | | |
| Yes | 128 (20.2) | 111 (17.7) | 172 (27.5) | 129 (20.6) |
| No | 45 (10.1) | 31 (7.0) | 76 (17.1) | 25 (5.6) |
Table 2 continued. Respondents’ attitudes towards the use of mHealth technologies to control diet, weight, and physical activity (n=1070).

| Variable | Mobile application to monitor physical activity | Mobile application to control the diet | A band or a watch to monitor physical activity | Smart bathroom scale |
|----------|-----------------------------------------------|--------------------------------------|-------------------------------------------------|----------------------|
|          | n (%)                                         | p                                    | n (%)                                           | p                    |
| Physical activity |                                 |                                      |                                                |                      |
| Everyday | 40 (22.7)                                     | <0.001                               | 29 (16.5)                                      | <0.001               |
|          | p                                              |                                      | p                                               |                      |
| 3-4 Times per week | 48 (24.9)                                    | 1.021                                | 37 (19.2)                                      | 0.001                |
|          | p                                              |                                      | p                                               |                      |
| 1-2 Times per week | 40 (18.2)                                    | 0.001                                | 30 (13.6)                                      | 0.001                |
|          | p                                              |                                      | p                                               |                      |
| 2-3 Times per month | 14 (14.3)                                     | 0.001                                | 19 (19.4)                                      | 0.001                |
|          | p                                              |                                      | p                                               |                      |
| Once per month | 8 (18.6)                                      | 0.001                                | 5 (11.6)                                       | 0.001                |
|          | p                                              |                                      | p                                               |                      |
| Less than once per month | 18 (12.6)                                    | 0.001                                | 13 (9.1)                                       | 0.001                |
|          | p                                              |                                      | p                                               |                      |
| Never | 6 (3.0)                                       | 0.001                                | 9 (4.6)                                        | 0.001                |

Tobacco use

| Tobacco | n (%) | p |
|---------|-------|---|
| Daily smoker | 36 (14.1) | 0.1 |
| Occasional smoker | 20 (23.3) | 0.08 |
| Non-smokers | 118 (16.2) | 0.051 |

Alcohol consumption

| Alcohol consumption | n (%) | p |
|---------------------|-------|---|
| Everyday | 8 (15.7) | 0.03 |
| 3-4 Times per week | 20 (18.2) | 0.001 |
| 1-2 Times per week | 48 (20.4) | 0.001 |
| 2-3 Times per month | 34 (18.3) | 0.001 |
| Once per month | 16 (13.8) | 0.001 |
| Less than once per month | 36 (16.7) | 0.001 |
| Never | 12 (7.6) | 0.001 |

Having gym/fitness club passes

| Having | n (%) | p |
|--------|-------|---|
| Yes | 42 (35.0) | 0.001 |
| No | 132 (13.9) | 0.001 |

Participation in organized/group sports activities

| Participation | n (%) | p |
|---------------|-------|---|
| Yes | 37 (31.9) | 0.001 |
| No | 137 (14.4) | 0.002 |
Table 3. Factors associated with the use of mobile apps to control diet, weight, and physical activity (n=1070).

| Variable                      | Mobile application to monitor physical activity level | Mobile application to control the diet |
|-------------------------------|-----------------------------------------------------|---------------------------------------|
|                               | Simple logistic regression | Multivariable logistic regression | Simple logistic regression | Multivariable logistic regression |
|                               | p | OR (95% CI) | p | OR (95% CI) | p | OR (95% CI) | p | OR (95% CI) |
| Gender                        |   |             |   |             |   |             |   |             |
| Female                        | 0.7 | 0.93 (0.67-1.29) | 0.1 | 1.32 (0.92-1.89) |
| Male                          | Reference | Reference | Reference | Reference |
| Age (years)                   |   |             |   |             |   |             |   |             |
| 18-29                         | <0.001 | 4.20 (2.47-7.13) | <0.001 | 3.77 (1.84-7.75) | <0.001 | 8.85 (4.28-18.33) | <0.001 | 7.73 (2.96-20.17) |
| 30-39                         | <0.001 | 2.88 (1.65-5.01) | 0.01 | 2.57 (1.26-5.24) | <0.001 | 5.73 (2.70-12.17) | 0.001 | 4.70 (1.81-12.17) |
| 40-49                         | 0.2 | 1.49 (0.79-2.79) | 0.4 | 1.41 (0.66-3.00) | <0.001 | 3.84 (1.73-8.52) | 0.006 | 3.83 (1.46-9.99) |
| 50-59                         | 0.5 | 1.27 (0.67-2.42) | 0.6 | 1.23 (0.59-2.57) | 0.1 | 1.95 (0.82-4.66) | 0.1 | 2.09 (0.81-5.43) |
| 60+                           | Reference | Reference | Reference | Reference |
| Educational level             |   |             |   |             |   |             |   |             |
| Primary                       | Reference | Reference | Reference | Reference |
| Vocational                    | 0.8 | 1.15 (0.39-3.46) | 0.8 | 1.26 (0.26-6.10) |
| Secondary                     | 0.8 | 0.89 (0.30-2.69) | 0.5 | 1.71 (0.40-7.46) |
| Higher                        | 0.4 | 0.57 (0.17-1.98) | 0.4 | 1.79 (0.41-7.80) |
| Marital status                |   |             |   |             |   |             |   |             |
| Single                        | 0.1 | 1.67 (0.91-3.05) | 0.6 | 0.79 (0.36-1.72) | 0.004 | 3.41 (1.48-7.88) | 0.8 | 1.12 (0.41-3.05) |
| Married                       | 0.9 | 0.96 (0.55-1.70) | 0.2 | 0.66 (0.35-1.26) | 0.047 | 2.26 (1.01-5.07) | 0.4 | 1.50 (0.62-3.65) |
| Informal relationship         | 0.04 | 1.93 (1.04-3.59) | 0.5 | 0.79 (0.37-1.68) | <0.001 | 4.16 (1.78-9.73) | 0.5 | 1.41 (0.53-3.74) |
| Divorced/widowed              | Reference | Reference | Reference | Reference |
| Having children               |   |             |   |             |   |             |   |             |
| Yes                           | <0.001 | Reference | Reference | Reference |
| No                            | 1.77 (1.28-2.46) | 1.07 (0.64-1.77) | 1.95 (1.36-2.78) | 0.1 | 1.69 (0.87-3.30) |
| Number of household members   |   |             |   |             |   |             |   |             |
| Living alone                  | 0.9 | 1.01 (0.63-1.61) |               | 0.7 | 0.90 (0.53-1.53) |
| Living with at least one person | Reference | Reference | Reference | Reference |
Table 3 continued. Factors associated with the use of mobile apps to control diet, weight, and physical activity (n=1070).

| Variable | Mobile application to monitor physical activity level | Mobile application to control the diet |
|----------|-----------------------------------------------------|---------------------------------------|
|          | Simple logistic regression | Multivariable logistic regression | Simple logistic regression | Multivariable logistic regression |
|          | p | OR (95% CI) | p | OR (95% CI) | p | OR (95% CI) | p | OR (95% CI) |
| Children under 18 years in home |  |  |  |  |  |  |  |  |
| Yes | 0.8 | 1.05 (0.75-1.47) |  |  | 0.045 | 1.45 (1.01-2.07) |  | 0.4 | 1.25 (0.71-2.19) |
| No | Reference |  | Reference | Reference |  | Reference | Reference |  |
| Place of residence |  |  |  |  |  |  |  |  |
| Rural | Reference | Reference | 0.8 | 0.93 (0.53-1.64) |  | Reference | Reference | Reference |
| City below 20,000 residents | 0.8 | 0.91 (0.50-1.67) | 0.6 | 0.84 (0.44-1.60) | 0.6 | 0.81 (0.40-1.65) |  |  |
| City from 20,000 to 99,999 residents | 0.02 | 1.72 (1.10-2.69) | 0.01 | 1.92 (1.17-3.16) | 0.7 | 1.14 (0.63-2.06) |  |  |
| City from 100,000 to 499,999 residents | 0.2 | 1.37 (0.85-2.21) | 0.3 | 1.33 (0.78-2.27) | 0.9 | 1.04 (0.56-1.92) |  |  |
| City above 500,000 residents | 0.02 | 1.85 (1.12-3.05) | 0.008 | 2.14 (1.22-3.74) |  | Reference |  |  |
| Occupational status |  |  |  |  |  |  |  |  |
| Active | <0.001 | 1.85 (1.29-2.66) | 0.3 | 1.25 (0.79-1.98) | 0.007 | 1.71 (1.16-2.53) | 0.8 | 0.94 (0.58-1.53) |
| Passive | Reference | Reference | Reference | Reference |  | Reference | Reference |  |
| Self-reported economic status |  |  |  |  |  |  |  |  |
| Rather good, good or very good | 0.2 | 1.31 (0.85-2.03) | 0.3 | 1.31 (0.82-2.09) |  | Reference |  |  |
| Moderate/difficult to tell | 0.7 | 0.92 (0.59-1.45) | 0.6 | 0.87 (0.53-1.42) |  | Reference |  |  |
| Rather bad, bad or very good | Reference | Reference |  |  |  |  |  |  |
| Presence of chronic diseases |  |  |  |  |  |  |  |  |
| Yes | 0.007 | Reference | 0.2 | Reference | 0.2 | 0.80 (0.56-1.14) |  |  |
| No | 1.59 (1.13-2.22) | 1.32 (0.88-1.98) | Reference |  |  | Reference |  |  |
| Self-reported health status |  |  |  |  |  |  |  |  |
| Rather good, good or very good | 0.3 | 1.40 (0.77-2.53) | 0.6 | 1.21 (0.64-2.28) |  | Reference |  |  |
| Moderate/difficult to tell | 0.4 | 0.76 (0.41-1.40) | 0.4 | 0.77 (0.40-1.47) |  | Reference |  |  |
| Rather bad, bad or very good | Reference | Reference |  |  |  |  |  |  |
### Table 3 continued. Factors associated with the use of mobile apps to control diet, weight, and physical activity (n=1070).

| Variable                        | Mobile application to monitor physical activity level | Mobile application to control the diet |
|--------------------------------|------------------------------------------------------|----------------------------------------|
|                                | Simple logistic regression | Multivariable logistic regression | Simple logistic regression | Multivariable logistic regression |
| **p**                          | **OR (95% CI)**             | **p** | **OR (95% CI)**             | **p** | **OR (95% CI)**             |
| **Having diet**                |                          |                          |                          |                          |                          |
| Yes                            | <0.001                   | 1.93 (1.38-2.70)         | 0.03                    | 1.54 (1.04-2.28)         | <0.001                   | 2.93 (2.04-4.21)         | <0.001                   | 2.71 (1.77-4.14)         |
| No                             | Reference                | Reference                | Reference                | Reference                |                          |                          |                          |                          |
| **Regular weight control**     |                          |                          |                          |                          |                          |                          |                          |                          |
| Yes                            | <0.001                   | 2.30 (1.60-3.31)         | 0.008                   | 1.76 (1.16-2.67)         | <0.001                   | 2.97 (1.89-4.36)         | 0.001                   | 2.19 (1.36-3.53)         |
| No                             | Reference                | Reference                | Reference                | Reference                |                          |                          |                          |                          |
| **Physical activity**          |                          |                          |                          |                          |                          |                          |                          |                          |
| Everyday                       | <0.001                   | 9.36 (3.86-22.70)        | <0.001                   | 5.58 (2.22-14.04)        | <0.001                   | 4.12 (1.89-9.98)         | 0.2                     | 1.78 (0.76-4.19)         |
| 3-4 Times per week             | <0.001                   | 10.54 (4.39-25.30)       | <0.001                   | 5.53 (2.21-13.86)        | <0.001                   | 4.95 (2.32-10.58)        | 0.1                     | 1.97 (0.85-4.55)         |
| 1-2 Times per week             | <0.001                   | 7.07 (2.93-17.09)        | 0.01                    | 3.31 (1.31-8.36)         | <0.001                   | 3.30 (1.53-7.14)         | 0.5                     | 1.31 (0.56-3.07)         |
| 2-3 Times per month            | <0.001                   | 5.31 (1.97-14.28)        | 0.04                    | 2.97 (1.06-8.35)         | <0.001                   | 5.02 (2.18-11.59)        | 0.06                    | 2.40 (0.97-5.95)         |
| Once per month                 | <0.001                   | 7.28 (2.38-22.26)        | 0.005                   | 5.34 (1.66-17.23)        | 0.08                     | 2.75 (0.87-8.66)         | 0.5                     | 1.54 (0.45-5.30)         |
| Less than once per month       | 0.002                    | 4.58 (1.77-11.87)        | 0.009                   | 3.65 (1.38-9.70)         | 0.1                      | 2.09 (0.87-5.03)         | 0.4                     | 1.57 (0.62-3.99)         |
| Never                          | Reference                | Reference                | Reference                | Reference                |                          |                          |                          |                          |
| **Tobacco use**                |                          |                          |                          |                          |                          |                          |                          |                          |
| Daily smoker                   | 0.4                      | 0.85 (0.57-1.27)         |                          |                          | 0.5                      | 1.14 (0.75-1.73)         | 0.06                    | 1.60 (0.99-2.60)         |
| Occasional smoker              | 0.1                      | 1.57 (0.92-2.68)         |                          |                          | 0.03                     | 1.90 (1.08-3.34)         | 0.5                     | 1.28 (0.65-2.53)         |
| Non-smokers                    | Reference                | Reference                | Reference                | Reference                |                          |                          |                          |                          |
| **Alcohol consumption**        |                          |                          |                          |                          |                          |                          |                          |                          |
| Everyday                       | 0.1                      | 2.25 (0.86-5.86)         | 0.1                     | 2.14 (0.76-6.02)         | 0.01                     | 3.24 (1.29-8.15)         | 0.06                    | 2.81 (0.99-7.97)         |
| 3-4 Times per week             | 0.01                     | 2.69 (1.25-5.76)         | 0.05                    | 2.22 (1.00-5.39)         | 0.02                     | 2.60 (1.17-5.75)         | 0.09                    | 2.17 (0.89-5.30)         |
| 1-2 Times per week             | <0.001                   | 3.10 (1.59-6.05)         | 0.02                    | 2.46 (1.19-5.11)         | 0.07                     | 1.94 (0.94-4.00)         | 0.5                     | 1.34 (0.60-2.98)         |
| 2-3 Times per month            | 0.005                    | 3.10 (1.59-6.05)         | 0.03                    | 2.34 (1.10-4.97)         | 0.008                    | 2.66 (1.29-5.48)         | 0.02                    | 2.52 (1.14-5.58)         |
| Once per month                 | 0.1                      | 1.93 (0.88-4.26)         | 0.2                     | 1.83 (0.78-4.26)         | 0.1                      | 1.97 (0.87-4.47)         | 0.3                     | 1.68 (0.68-4.11)         |
use of mobile apps to control diet, weight, and physical activity (n=1070).

| Factors associated with the use of mobile apps to control diet, weight, and physical activity |
|---------------------------------------------------------------|
| Variable                                                                 | Mobile application to monitor physical activity level | Mobile application to control the diet |
|                                                               | Simple logistic regression | Multivariable logistic regression | Simple logistic regression | Multivariable logistic regression |
|                                                               | p | OR (95% CI) | p | OR (95% CI) | p | OR (95% CI) | p | OR (95% CI) |
| Less than once per month                                      | 0.01 | 2.43 (1.22-4.84) | 0.03 | 2.26 (1.08-4.72) | 0.09 | 1.91 (0.92-3.97) | 0.1 | 1.96 (0.88-4.34) |
| Having gym/fitness club passes                                | Reference | Reference | Reference | Reference | Reference | Reference | Reference |
| Participation in organized/group sports activities             | Yes | <0.001 | 3.34 (2.20-5.07) | 0.05 | 1.60 (0.99-2.58) | <0.001 | 3.77 (2.44-5.83) | 0.01 | 1.94 (1.16-3.23) |
|                                                               | No | Reference | Reference | Reference | Reference | Reference | Reference |
| Participation in organized/group sports activities             | Yes | <0.001 | 2.79 (1.82-4.30) | 0.03 | 1.70 (1.04-2.76) | <0.001 | 3.60 (2.31-5.60) | 0.002 | 2.29 (1.36-3.87) |
|                                                               | No | Reference | Reference | Reference | Reference | Reference | Reference |

Discussion

This is the first nationally representative survey on the use of mobile apps and wearables among adults in Poland. In the past 12 months, almost one-quarter of respondents used wearables, and more than one-tenth used mobile apps to monitor diet or physical activity. Out of 19 different socioeconomic and lifestyle factors analyzed in this study, younger age, following a diet, regular physical activity, and participation in organized sports activities were significantly associated with the use of mobile apps and wearables. The lack of significant differences in the use of mobile apps and wearables by socioeconomic factors suggests that mHealth technologies are easily accessible and have a high potential for implementation for health management purposes.

The global prevalence of obesity has increased rapidly in the past decades, reaching pandemic levels [31]. The prevalence of diseases linked to obesity, such as cardiovascular diseases, type 2 diabetes, and cancer is also increasing [31]. Due to a high burden of lifestyle-related NCDs, effective interventions aimed to promote physical activity and healthy eating are a major public health challenge. Mobile health technologies, especially mobile applications (mobile apps) are considered easily accessible technologies that can significantly contribute to improvement of health status of the population [32]. Findings from several systematic reviews showed that mobile phone app-based interventions may be useful tools for weight control and loss [33-35]. Findings from this study showed that over one-tenth of adults in Poland used mobile apps to control diet (13.3%) or physical activity (16.3%). As the mHealth technology is relatively new, the percentage of adults in Poland who used mobile apps for health purposes seems to be high and has potential for further growth. As this is the first study to assess the prevalence of use of mobile apps for health purposes, comparison with other national studies from Poland is impossible due to limited data.

Out of 19 different socioeconomic and lifestyle factors analyzed in this study, there was no significant impact of economic status, educational level, or occupational status on the public attitudes towards the use of mobile apps, which shows the lack of socioeconomic barriers to accessing mobile apps. Numerous mobile apps are widely available and free of charge (often as a part of the smartphone's basic software) for smartphone users [19,20]. The lack of socioeconomic barriers to accessing mobile apps confirms its high potential to provide evidence-based public health interventions to different social groups. Moreover, the mHealth technology has potential for the implementation of personalized communication, which is crucial to improving the effectiveness of public health interventions [36]. However, the scientific credibility of mobile apps is one of the crucial barriers to the widespread implementation of mHealth technology in healthcare. Findings from studies on the agreement of popular nutrition-related apps with the national food-based dietary guidelines in Poland showed remarkable gaps in calculating energy and macronutrient intake [37]. Standardization of mobile apps and scientific verification of
Table 4. Factors associated with the use of wearables and Internet of Things technology to control diet, weight, and physical activity (n=1070).

| Variable                      | Simple logistic regression | Multivariable logistic regression | Simple logistic regression | Multivariable logistic regression |
|-------------------------------|----------------------------|-----------------------------------|----------------------------|-----------------------------------|
|                               | p  | OR (95% CI) | p  | OR (95% CI) | p  | OR (95% CI) | p  | OR (95% CI) |
| **Gender**                    |    |             |    |             |    |             |    |             |
| Female                        | 0.6 | 1.09 (0.82-1.44) | 0.5 | 0.88 (0.63-1.25) |    |             |    |             |
| Male                          | Reference | Reference | Reference | Reference |    |             |    |             |
| **Age (years)**               |    |             |    |             |    |             |    |             |
| 18-29                         | <0.001 | 3.27 (2.06-5.18) | <0.001 | 2.60 (1.53-4.39) | 0.5 | 1.17 (0.70-1.95) |    |             |
| 30-39                         | <0.001 | 2.45 (1.52-3.96) | 0.07 | 1.72 (0.96-3.07) | 0.3 | 1.32 (0.79-2.20) |    |             |
| 40-49                         | 0.01 | 1.90 (1.14-3.17) | 0.2 | 1.44 (0.78-2.67) | 0.7 | 1.90 (0.50-1.60) |    |             |
| 50-59                         | 0.01 | 1.92 (1.16-3.18) | 0.06 | 1.73 (0.98-3.06) | 0.8 | 1.08 (0.62-1.87) |    |             |
| 60+                           | Reference | Reference | Reference | Reference |    |             |    |             |
| **Educational level**         |    |             |    |             |    |             |    |             |
| Primary                       | Reference | Reference | Reference | Reference |    |             |    |             |
| Vocational                    | 0.5 | 1.61 (0.44-5.93) | 0.3 | 0.49 (0.12-2.05) |    |             |    |             |
| Secondary                     | 0.2 | 2.19 (0.64-7.46) | 0.6 | 1.35 (0.39-4.65) |    |             |    |             |
| Higher                        | 0.2 | 2.23 (0.65-7.61) | 0.8 | 1.18 (0.34-4.07) |    |             |    |             |
| **Marital status**            |    |             |    |             |    |             |    |             |
| Single                        | Reference | Reference | Reference | Reference |    |             |    |             |
| Married                       | 0.6 | 1.12 (0.66-1.88) | 0.2 | 1.46 (0.78-2.72) |    |             |    |             |
| Informal relationship         | 0.1 | 1.44 (0.91-2.28) | 0.05 | 1.98 (0.99-3.94) |    |             |    |             |
| Divorced/widowed              | 0.7 | 1.12 (0.66-1.88) | Reference | Reference |    |             |    |             |
| **Having children**           |    |             |    |             |    |             |    |             |
| Yes                           | 0.6 | 0.92 (0.68-1.23) | 0.5 | 0.90 (0.63-1.27) |    |             |    |             |
| No                            | Reference | Reference | Reference | Reference |    |             |    |             |
| **Number of household members** |    |             |    |             |    |             |    |             |
| Living alone                  | 0.04 | Reference | Reference | Reference | 0.8 | 0.93 (0.56-1.54) |    |             |
### Table 4 continued. Factors associated with the use of wearables and Internet of Things technology to control diet, weight, and physical activity (n=1070).

| Variable                                      | A band or a watch to monitor physical activity (Simple logistic regression) | Smart bathroom scale (Multivariable logistic regression) | A band or a watch to monitor physical activity (Simple logistic regression) | Smart bathroom scale (Multivariable logistic regression) |
|-----------------------------------------------|-----------------------------------------------------------------------------|-----------------------------------------------------------|-----------------------------------------------------------------------------|-----------------------------------------------------------|
| Living with at least one person               | 1.64 (1.03-2.61)                                                            | Reference                                                 | 0.7                                                                         | 1.11 (0.67-1.85)                                           |
| Children under 18 years in home               |                                                                             |                                                           |                                                                             |                                                           |
| Yes                                           | 1.67 (1.25-2.23)                                                            | Reference                                                 | 0.05                                                                        | 1.41 (1.00-1.99)                                           |
| No                                            | Reference                                                                   | Reference                                                 | Reference                                                                   | Reference                                                 |
| Place of residence                             |                                                                             |                                                           |                                                                             |                                                           |
| Rural                                         | 1.37 (0.84-2.22)                                                            | 0.9                                                       | 1.03                                                                        | (0.59-1.80)                                               |
| City below 20,000 residents                   | 1.40 (0.79-2.50)                                                            | 0.9                                                       | 1.06                                                                        | (0.54-2.08)                                               |
| City from 20,000 to 99,999 residents           | 1.52 (0.91-2.53)                                                            | 0.8                                                       | 1.10                                                                        | (0.60-2.00)                                               |
| City from 100,000 to 499,999 residents         | 1.45 (0.86-2.45)                                                            | 0.5                                                       | 1.26                                                                        | (0.69-2.30)                                               |
| City above 500,000 residents                  | Reference                                                                   | Reference                                                 | Reference                                                                   | Reference                                                 |
| Occupational status                            |                                                                             |                                                           |                                                                             |                                                           |
| Active                                        | 1.83 (1.34-2.50)                                                            | 0.3                                                       | 1.22                                                                        | (0.83-1.79)                                               |
| Passive                                       | Reference                                                                   | Reference                                                 | Reference                                                                   | Reference                                                 |
| Self-reported economic status                  |                                                                             |                                                           |                                                                             |                                                           |
| Rather good, good or very good                | 1.87 (1.25-2.80)                                                            | 0.03                                                      | 1.65                                                                        | (1.07-2.54)                                               |
| Moderate/difficult to tell                     | 1.29 (0.86-1.95)                                                            | 0.3                                                       | 1.26                                                                        | (0.82-1.95)                                               |
| Rather bad, bad or very good                  | Reference                                                                   | Reference                                                 | Reference                                                                   | Reference                                                 |
| Presence of chronic diseases                   |                                                                             |                                                           |                                                                             |                                                           |
| Yes                                           | 0.95 (0.71-1.26)                                                            | 0.04                                                      | 1.43                                                                        | (1.02-2.02)                                               |
| No                                            | Reference                                                                   | Reference                                                 | Reference                                                                   | Reference                                                 |
| Self-reported health status                    |                                                                             |                                                           |                                                                             |                                                           |
| Rather good, good or very good                | 0.99 (0.60-1.64)                                                            | 0.3                                                       | 0.74                                                                        | (0.42-1.32)                                               |
| Moderate/difficult to tell                     | 0.81 (0.49-1.35)                                                            | 0.2                                                       | 0.67                                                                        | (0.38-1.18)                                               |
| Variable                              | A band or a watch to monitor physical activity | Smart bathroom scale |
|---------------------------------------|------------------------------------------------|----------------------|
| **Rather bad, bad or very good**      | Simple logistic regression                      | Multivariable logistic regression |
| Reference                             | Reference                                      | Reference            |
| **Having diet**                       | p OR (95% CI)                                  | p OR (95% CI)        |
| Yes                                   | 0.004 (1.15-2.10)                              | 0.1 (0.92-1.82)      |
| No                                    | Reference                                      | Reference            |
| **Regular weight control**            | Simple logistic regression                      | Multivariable logistic regression |
| Reference                             | Reference                                      | Reference            |
| Yes                                   | 0.001 (1.36-2.48)                              | 0.01 (1.10-2.16)     |
| No                                    | Reference                                      | Reference            |
| **Physical activity**                 | Simple logistic regression                      | Multivariable logistic regression |
| Reference                             | Reference                                      | Reference            |
| Everyday                              | <0.001 (1.98-5.93)                             | 0.006 (1.27-4.09)    |
| 3-4 Times per week                   | <0.001 (1.84-5.45)                             | <0.001 (1.23-12.68)  |
| 1-2 Times per week                   | <0.001 (1.51-4.44)                             | <0.001 (1.59-7.39)   |
| 2-3 Times per month                  | 0.007 (1.28-4.65)                              | 0.01 (1.32-7.76)     |
| Once per month                       | 0.04 (1.05-5.56)                               | 0.03 (1.14-10.09)    |
| Less than once per month             | 0.01 (1.21-3.99)                               | 0.05 (0.87-5.03)     |
| Never                                 | Reference                                      | Reference            |
| **Tobacco use**                       | Simple logistic regression                      | Multivariable logistic regression |
| Reference                             | Reference                                      | Reference            |
| Daily smoker                          | 0.7 (0.76-1.49)                                | 0.3 (0.86-1.79)      |
| Occassional smoker                    | 0.02 (1.12-2.92)                               | 0.2 (0.82-2.33)      |
| Non-smokers                           | Reference                                      | Reference            |
| **Alcohol consumption**               | Simple logistic regression                      | Multivariable logistic regression |
| Reference                             | Reference                                      | Reference            |
| Everyday                              | 0.09 (0.91-4.02)                               | 0.3 (0.70-3.47)      |
| 3-4 Times per week                   | 0.2 (0.80-2.74)                                | 0.7 (0.58-2.15)      |
| 1-2 Times per week                   | 0.03 (1.06-2.95)                               | 0.3 (0.76-2.29)      |
| 2-3 Times per month                  | 0.01 (1.15-3.32)                               | 0.07 (0.96-2.96)     |

Table 4 continued. Factors associated with the use of wearables and Internet of Things technology to control diet, weight, and physical activity (n=1070).
Factors associated with the use of wearables and Internet of Things technology to control diet, weight, and physical activity (n=1070).

| Variable | Simple logistic regression | Multivariable logistic regression | Simple logistic regression | Multivariable logistic regression |
|----------|---------------------------|----------------------------------|---------------------------|----------------------------------|
|          | p | OR (95% CI) | p | OR (95% CI) | p | OR (95% CI) | p | OR (95% CI) |
| Once per month | 0.3 | 1.38 (0.75-2.55) | 0.6 | 1.18 (0.62-2.26) | 0.04 | 2.09 (1.03-4.26) | 0.07 | 2.01 (0.95-4.26) |
| Less than once per month | 0.3 | 1.33 (0.78-2.28) | 0.4 | 1.26 (0.72-2.22) | 0.8 | 1.08 (0.54-2.15) | 0.9 | 0.96 (0.47-1.98) |

**Having gym/fitness club passes**

| Yes | <0.001 | 2.40 (1.61-3.57) | 0.1 | 1.41 (0.91-2.19) | <0.001 | 2.47 (1.58-3.86) | 0.07 | 1.58 (0.97-2.58) |
| No | Reference | Reference | Reference | Reference | Reference |

**Participation in organized/group sports activities**

| Yes | <0.001 | 2.45 (1.64-3.66) | 0.01 | 1.79 (1.15-2.80) | 0.002 | 2.09 (1.31-3.33) | 0.3 | 1.28 (0.77-2.13) |
| No | Reference | Reference | Reference | Reference |

their content is crucial to increasing the use of mobile apps in healthcare settings.

In addition to the lifestyle mobile apps and wearables, there is a dedicated group of mHealth technologies targeted at patients with chronic diseases [23,38,39]. Findings from the systematic review on the use of mobile apps for the improvement of diabetic care showed that the use of mobile apps eases the management of the lifestyle of diabetic patients (including diet and physical activity) and improves short-term glycemic control [38]. Moreover, findings from the systematic review of 16 randomized control trials on the use of mobile apps in the management of cardiovascular diseases showed that this technology has an acceptable degree of usability and tended to increase medication adherence among patients with cardiovascular diseases [39]. In this study, there were no significant differences in the use of mobile apps and wearables by health status. Further actions are needed to promote the use of mobile apps and wearables among patients with chronic diseases.

Findings from this study showed that wearables such as bands or watches with sensors were the most common mHealth technologies used by adults in Poland. Similarly, as in the case of mobile apps, younger adults were more likely to use wearables. Age is an important barrier to accessing mHealth technologies. Cognition, motivation, physical ability, and perception were identified as the major categories of aging barriers influencing the usability of mHealth technologies [40]. In this study, good financial status was significantly associated with higher odds of using wearables. Contrary to mobile apps, wearables must be purchased. However, the variety of products and their price makes these products more and more available.

In this study, lifestyle factors such as following a diet, regular weight control, regular physical activity, the use of sports services such as gym passes, and group training were the most important factors associated with use of mobile apps and wearables. This finding suggests that mobile apps and wearables are currently used as lifestyle devices that facilitate monitoring of diet, weight, and physical activity, rather than as medical devices to manage health conditions. Further educational, organizational, and legal activities are needed to promote the development of mHealth technologies.

This study has practical implications for healthcare professionals and public authorities in Poland. Our study provides data on public attitudes on the use of mobile apps and wearables to monitor diet, weight, and physical activity. Findings from this study may be used by policymakers to improve mHealth services in Poland. The lack of differences in the use of mobile apps and wearables by health status suggests that there is a need to educate physicians and patients on the potential benefits of use of mHealth for chronic disease management. Moreover, this study revealed barriers to the use of mHealth technologies.
services by age. In the face of an aging society, the elderly should be encouraged to use mHealth solutions. The available technologies are often tailored to the needs of seniors and their mHealth literacy level.

This study has several limitations. The study questionnaire was self-prepared and limited to the 4 most common mobile health technologies. The mHealth market is still developing, so the number of mHealth technologies is constantly increasing. Moreover, data on the products/brands were not collected. Questions on the frequency of use of mHealth solutions were also not included. This study was carried out on a representative sample of adults in Poland. Further research on mHealth technology use in subgroups of patients with chronic diseases is needed to assess the implementation of mHealth in the management of NCDs.

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Conclusions

This study produced data on the use of mobile apps and wearables among adults in Poland. One-quarter of adults in Poland regularly used wearables and over one-tenth used mobile apps to monitor diet or physical activity. Significant age-related barriers to accessing mHealth technology were observed. The use of mobile apps and wearables depend on lifestyle factors such as diet, regular weight control, and physical activity. A lack of socioeconomic barriers to accessing mobile apps and wearables presented in this study suggests that mHealth technology can be used to promote a healthy lifestyle in different socioeconomic groups and can reduce health inequalities.
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