Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

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Health-, medication- and dietary supplement-related behaviors and beliefs relatively unchanged during the COVID-19 pandemic lockdown

Michał Seweryn Karbownik [a,*], Maria Dobielska [b], Ewelina Paul [c], Radosław Przemysław Kowalczyk [d], Edward Kowalczyk [a]

[a] Department of Pharmacology and Toxicology, Medical University of Lodz, 7/9 Zeligowskiego Str, Lodz, 90-752, Poland
[b] Students' Research Club, Department of Pharmacology and Toxicology, Medical University of Lodz, 7/9 Zeligowskiego Str, Lodz, 90-752, Poland
[c] OSOM STUDIO, 47 Jaracza Str, Lodz, 90-249, Poland
[d] Independent Scientist, Berlin, Germany

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ABSTRACT

Background: The lockdown imposed to counter the coronavirus disease 2019 (COVID-19) pandemic has evoked an unprecedented phenomenon that could affect health behaviors and beliefs.
Objective: To examine how medication-, dietary supplement- and health-related behaviors, beliefs and other psychological constructs changed in Polish online health service users during the COVID-19 pandemic lockdown.
Methods: A one-time online survey accessed through a health service website was completed before and during the pandemic lockdown by separate samples of respondents. The survey examined beliefs about medicines and dietary supplements, consumption of dietary supplements, trust and contact with their advertisements, sources of dietary supplement knowledge as well as perceived health, diet, physical activity and smoking, among other things.
Results: The study included 1560 participants. Most examined outcomes remained unchanged over COVID-19 pandemic lockdown. Beliefs that the dietary supplement quality is well controlled became significantly more pronounced during the lockdown (adjusted ratio of estimates 1.16, 95%CI 1.06–1.27, $p = 0.001$). Fewer people reported having contact with dietary supplement advertisements (adjusted odds ratio 0.59, 95%CI 0.43–0.83, $p = 0.002$).
Conclusions: The results may help understand some health-related issues associated with COVID-19 pandemic lockdown and may be used to shape aspects of health-related policy.

Introduction

The coronavirus disease 2019 (COVID-19) pandemic has evoked an unprecedented global crisis.[1] Soon after the first cases were identified in Poland, in early March 2020, far-reaching restrictions were introduced. Educational institutions from nurseries to universities were closed overnight, followed by the closure of cultural institutions, multiple retail outlets and service facilities. Social and religious gatherings were strictly limited and non-essential travel was forbidden (Fig. 1). Health care services were deprioritized in favor of COVID-19 cases.[2] Trapped at home, overwhelmed by mass media reports,[3] afraid they will get COVID-19,[4] uncertain about their financial[5] and health[6] situation, people were more likely to switch to a sedentary lifestyle with poor dietary behaviors,[7] and experience greater anxiety and depressive symptoms.[7,8] Ironically, such situation could exacerbate non-COVID-19 diseases.[2,6,7]

During such a widespread health crisis,[4,6] it would be natural for people to turn to self-medication.[9,10] Indeed, public interest has grown regarding the influence of medications and self-medication for COVID-19,[11] as well as for other conditions,[12] and despite there being little evidence indicating that dietary supplementation may counter the effects of COVID-19,[13] the purchase of dietary supplements (DS) has also increased.[9,10] Although few studies have examined the behaviors and beliefs related to medications, dietary supplementation and overall health during the COVID-19 pandemic, they could have a significant effect on public health during lockdown periods.

Abbreviations: B-H, Benjamini and Hochberg; CI, confidence intervals; COVID-19, coronavirus disease 2019; DS, dietary supplements; GLM, general linear model.

* Corresponding author. 7/9 Zeligowskiego Str., Lodz, 90-752, Poland.
E-mail address: michal.karbownik@umed.lodz.pl (M.S. Karbownik).

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The aim of this study was to evaluate the changes in selected behaviors, beliefs and some other psychological constructs related to medication, DS and health among users of an online health service during the COVID-19 pandemic lockdown in Poland.

Materials and methods

Procedure

A one-time online survey was made available through multiple sources, including the main website of a popular[14] Polish online health service and online pharmacy (DOZ.pl) between November 26, 2019 and March 11, 2020. The survey tested knowledge regarding dietary supplements and their use among the general public according to a pre-registered protocol[15] (i.e. the *primary study*[14]). For the purposes of the present study, only data obtained through the main DOZ.pl website for the period February 1, 2020 and March 11, 2020, i.e. the *pre-pandemic* period, was extracted.

Following this, the same one-time online survey was then made available a second time between March 15 and May 25, 2020 (i.e. the *secondary study*: *pandemic* period), but only through the DOZ.pl main website. The two sets of results from the *pre-pandemic* and *pandemic* surveys were then compared. The study timeline in relation to the COVID-19 pandemic lockdown in Poland is presented in Fig. 1. The study was approved by the Bioethics Committee of the Medical University of Lodz, Poland (KE/1382/19 with amendments).

Research instrument

Apart from the introduction, the online survey used in the study (Survio; Brno, Czech Republic) comprised 4 parts. The first was related to knowledge and beliefs about DS. It consisted of the recently-developed 17-item Questionnaire on Knowledge about DS.[16] Reversed total score of the answers to its 4 attitudinal items related to control over quality, composition, efficacy and safety of DS as well as reversed total score of the answers to its 7 attitudinal items related to DS efficacy in disease prevention were used to assess respective beliefs[17,18] (see Supplementary Material).

Of the remaining parts, the second was related to DS advertising. It consisted of a single-item measure of having contact with DS advertisements within the past week, as well as a recently-developed Questionnaire on Trust in Advertising DS.[16] The third part comprised the General part of Beliefs about Medicines Questionnaire[19] in its Polish version.[20] The fourth part included a set of partially validated[15] single-item measures of other medical and DS issues such as perceived health, diet and physical activity, cigarette smoking and e-cigarette use, use of any DS within past 30 days, personal experience of DS effects, sources of knowledge about DS. This part also referred to sociodemographic data including age, sex, educational level, having medical education, number of inhabitants in a place of residence and monthly net household earnings per a family member. A detailed description and operationalization of the applied measures as well as the survey wording and layout are presented in the report of the primary study[14] and its protocol.[15]

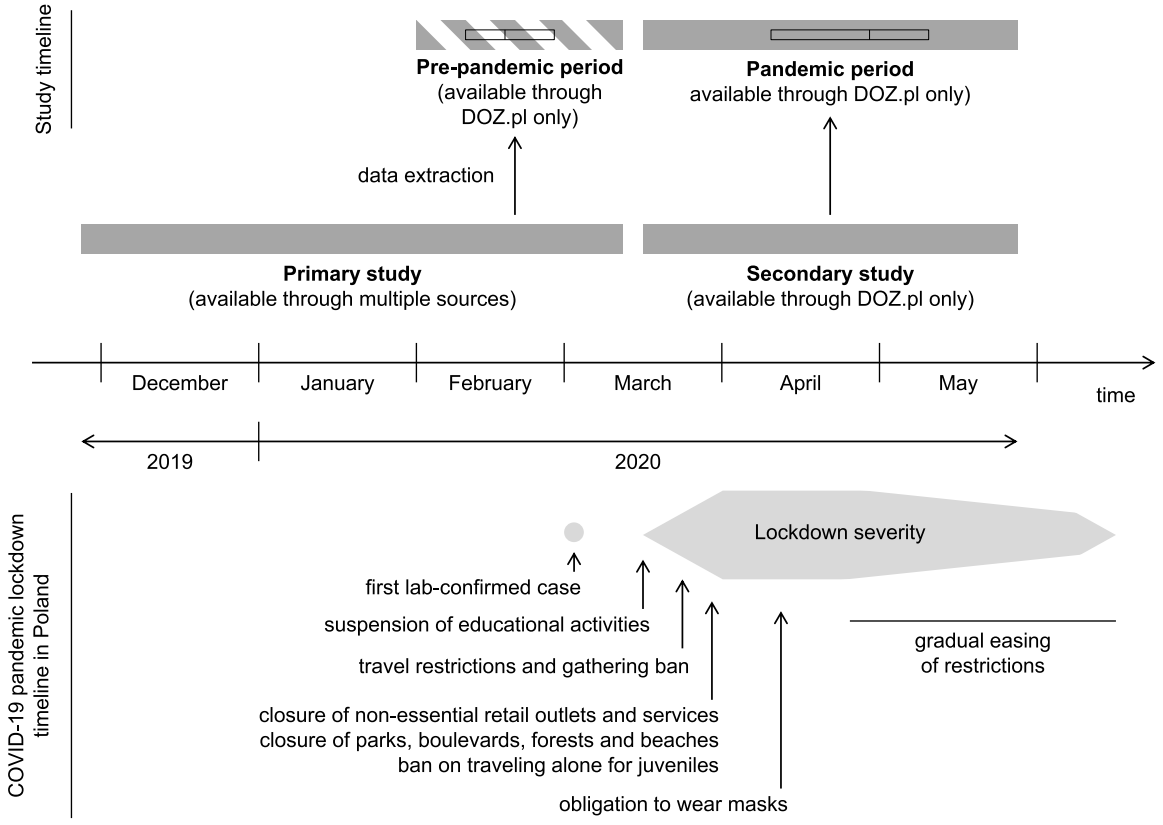

Fig. 1. Timeline of the study in relation to COVID-19 pandemic lockdown in Poland. The part above the time axis illustrates the study procedure (description in text). Box plots within the rectangles representing the study periods depict the data for median and 1st and 3rd quartile of participant number. The major stages of the COVID-19 lockdown in Poland are given beneath the timeline.

Data analysis

The following cases from both time periods were included to the analysis; respondents who accessed the survey through DOZ.pl main website, those with a survey completion time of at least 2:30 min and with no more than 50% of missing values. In addition, all participants had to be 18 years of age or above, with no formal medical education.[14] As there were 1126 cases who met these criteria in the pre-pandemic period, the minimum required size of the pandemic period subsample was estimated to be 180 to reach Cohen's *d* of 0.2 (small effect size) at the statistical power of 0.8. Cases with missing data were imputed using a multiple imputation by chained equation procedure under a *missing at random* assumption about the unobserved data.

Data collected in the pre-pandemic period was compared to that from the second survey i.e. the pandemic period. Ordinal outcome variables with at least 3 levels were assessed with the use of general linear model (GLM) analyses. Additionally, variation within these variables was tested between the groups of interest using Levene's test. Dichotomous outcome variables were compared with the use of logistic regression. The analyses were carried out both as raw and with adjustment to sociodemographic data, which were considered potential confounders. False discovery rate was controlled at the level of 0.05 with the Benjamini-Hochberg (B-H) correction for testing multiple hypotheses. A *p*-value lower than B-H corrected significance level, or 0.05 in case of exploratory analyses, was considered statistically significant. The analysis was performed using Statistica Software version 13.3 (StatSoft; Tulsa, OK, USA) and R Software version 4.0.0 with package "mice" version 3.8.0 (R Foundation for Statistical Computing; Vienna, Austria).

Results

Characteristics of study participants

In total, the study included data from 1560 people: 1126 who participated in the study in the pre-pandemic period (median response on February 17, 1st-3rd quartile February 12 – February 26), and 434 in the pandemic period (median response on April 27, 1st-3rd quartile April 08 – May 11) (Fig. 1). The pandemic dataset was characterized by a higher level of missing data (0.94%) than the pre-pandemic period sample (odds ratio 1.62, 95%CI 1.37–1.92).

For the total sample, the median age of the study participants was 35 years (range 18–90 years) and nearly 85% were female. While the participants in the pandemic period were found younger and less educated than those in the pre-pandemic one, none of the other sociodemographic parameters differed significantly between the groups (Table 1).

A comparison of behaviors, beliefs and other psychological constructs between the pre-pandemic and pandemic periods

No significant differences were observed between the two periods regarding the majority of the tested parameters. However, the pandemic period was characterized by significantly more pronounced beliefs that DS are well controlled in terms of quality, composition, efficacy and safety; in addition, the respondents were less likely to report having contact with DS advertisements than in the pre-pandemic period. Both significant results survived adjustment for potential sociodemographic confounders (Table 2).

The extent of physical activity appeared less variable in the pandemic lockdown than before, but this difference in variation was of borderline statistical significance. Mean value did not appear to differ between study periods (Table 2). Exploratory GLM modeling of physical activity was therefore performed, with the study period, any sociodemographic variables and their two-way interaction as predictors. Only the inclusion of place of residence returned a significant result for the interaction, which survived adjustment for potential confounders ($F(1,1552) = 5.39$, $p = 0.020$, full model $R^2 = 0.018$). The residents of villages and towns below 5000 inhabitants, who tended to be less active than largest city residents before the pandemic, increased their physical activity during the lockdown (adjusted ratio of estimates 1.13, 95%CI 1.03–1.25). On the other hand, residents of the largest cities appeared insignificantly less active in the lockdown as compared to the pre-pandemic time period (adjusted ratio of estimates 0.96, 95%CI 0.89–1.04).

Table 1
Sociodemographic characteristics of the study participants. The table includes data for all participants, as well as a comparison of data from the pre-pandemic and pandemic periods.

Characteristics	Total sample (N = 1560)	Difference between the study periods		
		Pre-pandemic (n = 1126)	Pandemic (n = 434)	Test statistics and *p*-value for the comparison[a]
	Mean (standard deviation) with *median (1st-3rd quartile)* or number (frequency)			
Age [years]	38.2 (13.3) *35 (28–46)*	38.9 (13.0) *36 (29–46)*	36.4 (13.9) *33 (25–44)*	$Z = 4.40$, $p < 0.0001$
Sex				
Female	1319 (84.6%)	950 (84.4%)	369 (85.0%)	$\chi^2(1) = 0.10$, $p = 0.75$
Male	241 (15.4%)	176 (15.6%)	65 (15.0%)	
Educational level				
Primary	12 (0.8%)	6 (0.5%)	6 (1.4%)	$Z = 2.83$, $p = 0.0046$
Secondary or vocational	430 (27.6%)	298 (26.5%)	132 (30.4%)	
Higher – bachelor	317 (20.3%)	215 (19.1%)	102 (23.5%)	
Higher – master	771 (49.4%)	588 (52.2%)	183 (42.2%)	
Higher – doctorate	30 (1.9%)	19 (1.7%)	11 (2.5%)	
Number of inhabitants in a place of residence				
Below 5000	213 (13.6%)	145 (12.9%)	68 (15.7%)	$Z = 0.67$, $p = 0.50$
5000-50,000	328 (21.0%)	240 (21.3%)	88 (20.3%)	
50,000–500,000	531 (34.0%)	388 (34.5%)	143 (33.0%)	
Over 500,000	488 (31.3%)	353 (31.4%)	135 (31.1%)	
Monthly net household earnings per a family member				
Below 1000 PLN	97 (6.2%)	76 (6.8%)	21 (4.8%)	$Z = 1.46$, $p = 0.14$
1000–2000 PLN	418 (26.8%)	283 (25.1%)	135 (31.1%)	
2000–3000 PLN	525 (33.7%)	379 (33.7%)	146 (33.6%)	
Over 3000 PLN	520 (33.3%)	388 (34.5%)	132 (30.4%)	

PLN – Polish złoty.
Benjamini-Hochberg corrected significance level is 0.020.
[a] Asymptotic Mann Whithney *U* test (*Z* statistics is provided) or chi-square test (χ^2(df) is provided).

Discussion

The behaviors, beliefs and other psychological constructs related to medication and dietary supplements, as well as some health issues, may have a direct influence on health outcomes.[19,20] As the COVID-19 pandemic lockdown, which occurred in spring 2020, substantially affected functioning of billions of people worldwide, any deterioration in such behaviors and beliefs in this time could have dramatic consequences.

Our findings indicate that most of the studied parameters changed insignificantly over the pandemic lockdown period. Beliefs that

Table 2
Comparison of medication-, dietary supplement- and health-related behaviors, beliefs and other psychological constructs between the pre-pandemic and pandemic periods.

Variable	Comparison between the periods		Test for difference in estimates[a]				Test for difference in variance[c]
	Pre-pandemic	Pandemic	Raw analysis		Adjusted analysis[b]		
	Estimate[d] (95%CI)		Effect size[e] (95%CI)	Test statistics and *p*-value[f]	Effect size[e] (95%CI)	Test statistics and *p*-value[f]	Test statistics and *p*-value
Medication-related							
Beliefs about medicines – overuse[g]	13.2 (13.0–13.4)	13.2 (12.9–13.5)	1.00 (0.97–1.03)	$F(1,1558) = 0.01$, $p = 0.93$	1.00 (0.97–1.04)	$F(1,1553) = 0.01$, $p = 0.92$	$F(1,1558) = 0.27$, $p = 0.61$
Beliefs about medicines – harm[g]	9.7 (9.5–9.9)	9.6 (9.3–9.9)	0.99 (0.95–1.02)	$F(1,1558) = 0.57$, $p = 0.45$	0.98 (0.95–1.02)	$F(1,1553) = 0.79$, $p = 0.37$	$F(1,1558) = 0.66$, $p = 0.42$
Dietary supplement-related							
Beliefs about DS – control[h]	1.8 (1.7–1.9)	2.1 (1.9–2.3)	**1.18 (1.08–1.29)**	**$F(1,1558)=12.61$, $p=0.0004$**[i]	**1.16 (1.06–1.27)**	**$F(1,1553)=10.65$, $p=0.0011$**	$F(1,1558) = 0.06$, $p = 0.80$
Beliefs about DS – efficacy[j]	4.5 (4.4–4.6)	4.5 (4.4–4.6)	0.99 (0.96–1.03)	$F(1,1558) = 0.07$, $p = 0.79$	1.00 (0.96–1.04)	$F(1,1553)<0.01$, $p = 0.95$	$F(1,1558) = 1.98$, $p = 0.16$
Use of DS within past 30 days	80% (78%–82%)	78% (74%–82%)	0.87 (0.66–1.14)	$\chi^2(1) = 1.04$, $p = 0.31$	0.91 (0.69–1.19)	$\chi^2(1) = 0.47$, $p = 0.49$	NA
Positive experience of DS effects	57% (54%–60%)	54% (50%–59%)	0.91 (0.73–1.14)	$\chi^2(1) = 0.70$, $p = 0.40$	0.94 (0.75–1.17)	$\chi^2(1) = 0.32$, $p = 0.57$	NA
Negative experience of DS effects	3% (2%–4%)	4% (3%–7%)	1.53 (0.85–2.76)	$\chi^2(1) = 1.98$, $p = 0.16$	1.46 (0.80–2.66)	$\chi^2(1) = 1.56$, $p = 0.21$	NA
Being interested in DS[k]	3.1 (3.0–3.1)	3.1 (3.0–3.2)	0.99 (0.96–1.03)	$F(1,1558) = 0.13$, $p = 0.72$	0.99 (0.96–1.03)	$F(1,1553) = 0.12$, $p = 0.73$	$F(1,1558) = 0.37$, $p = 0.54$
Getting knowledge about DS from medical doctors[l]	0.8 (0.8–0.9)	0.8 (0.7–0.9)	0.97 (0.86–1.08)	$F(1,1558) = 0.30$, $p = 0.58$	0.97 (0.87–1.09)	$F(1,1553) = 0.24$, $p = 0.62$	$F(1,1558) = 0.03$, $p = 0.87$
Getting knowledge about DS from pharmacists[l]	1.0 (0.9–1.0)	1.1 (1.0–1.1)	1.06 (0.97–1.17)	$F(1,1558) = 1.63$, $p = 0.20$	1.05 (0.96–1.16)	$F(1,1553) = 1.24$, $p = 0.26$	$F(1,1558) = 1.78$, $p = 0.18$
Getting knowledge about DS from dieticians[l]	0.5 (0.5–0.6)	0.5 (0.5–0.6)	1.09 (0.91–1.29)	$F(1,1558) = 0.91$, $p = 0.34$	1.07 (0.90–1.26)	$F(1,1553) = 0.54$, $p = 0.46$	$F(1,1558) = 4.51$, $p = 0.034$
Getting knowledge about DS from friends[l]	0.8 (0.7–0.8)	0.7 (0.6–0.8)	0.90 (0.79–1.01)	$F(1,1558) = 3.17$, $p = 0.075$	0.89 (0.78–1.00)	$F(1,1553) = 3.64$, $p = 0.057$	$F(1,1558) = 0.95$, $p = 0.33$
Getting knowledge about DS from media[l]	1.5 (1.4–1.6)	1.4 (1.3–1.5)	0.94 (0.87–1.02)	$F(1,1558) = 2.39$, $p = 0.12$	0.95 (0.88–1.03)	$F(1,1553) = 1.58$, $p = 0.21$	$F(1,1558) = 1.12$, $p = 0.29$
Having contact with DS ads within past week	91% (89%–92%)	85% (81%–88%)	**0.60 (0.43–0.83)**	**$\chi^2(1)=9.42$, $p=0.0021$**	**0.59 (0.43–0.83)**	**$\chi^2(1)=9.34$, $p=0.0022$**	NA
Trust in advertising DS[m]	18.9 (18.5–19.2)	19.3 (18.8–19.8)	1.02 (0.99–1.05)	$F(1,1558) = 1.73$, $p = 0.19$	1.02 (0.99–1.05)	$F(1,1553) = 1.50$, $p = 0.22$	$F(1,1558) = 4.40$, $p = 0.036$
Health-related							
Perceived health[n]	2.6 (2.5–2.6)	2.6 (2.5–2.6)	1.00 (0.96–1.03)	$F(1,1558) = 0.06$, $p = 0.80$	0.99 (0.96–1.02)	$F(1,1553) = 0.28$, $p = 0.59$	$F(1,1558) = 0.01$, $p = 0.91$
Diet[k]	3.5 (3.4–3.5)	3.4 (3.3–3.5)	0.98 (0.96–1.01)	$F(1,1558) = 1.35$, $p = 0.25$	1.00 (0.97–1.02)	$F(1,1553) = 0.02$, $p = 0.88$	$F(1,1558) = 0.13$, $p = 0.72$
Physical activity[k]	2.8 (2.7–2.8)	2.8 (2.7–2.9)	1.01 (0.97–1.05)	$F(1,1558) = 0.08$, $p = 0.78$	1.01 (0.97–1.06)	$F(1,1553) = 0.49$, $p = 0.49$	$F(1,1558) = 8.49$, $p = 0.0036$[o]
Current cigarettesmoking	9% (8%–11%)	12% (9%–15%)	1.29 (0.90–1.85)	$\chi^2(1) = 1.99$, $p = 0.16$	1.27 (0.88–1.82)	$\chi^2(1) = 1.64$, $p = 0.20$	NA
Current e-cigarette use	2% (1%–3%)	1% (0%–3%)	0.54 (0.20–1.41)	$\chi^2(1) = 1.60$, $p = 0.21$	0.54 (0.20–1.44)	$\chi^2(1) = 1.52$, $p = 0.22$	NA

CI – confidence intervals.
DS – dietary supplements.
NA – not applicable.
The result presented in bold are statistically significant at the Benjamini-Hochberg corrected significance level of 0.0050 for raw and adjusted analyses of difference in estimates, and of 0.0036 for analyses of difference in variance.

[a] General Linear Model analyses (for ordinal outcome variables with at least 3 levels) or logistic regression analyses (for dichotomous outcome variables).

[b] Adjusted for age, sex, educational level, number of inhabitants in a place of residence and monthly net household earnings per a family member – all included to the analyses in a linear way.

[c] Performed with the use of Levene's test.

[d] Arithmetic mean (for ordinal outcome variables with at least 3 levels) or frequency (for dichotomous outcome variables).

[e] Ratio of pandemic to pre-pandemic outcome variable estimate (for ordinal outcome variables with at least 3 levels) or odds ratio (for dichotomous outcome variables).

[f] Fisher-Snedecor test statistics (in case of General Linear Model analyses) or Wald chi-square test statistics (in case of logistic regression).

[g] Estimate range 4–20.

[h] Estimate range 0–4. Cronbach's alpha of the scale = 0.83.

[i] The result remains significant with non-parametric asymptotic Mann Whithney *U* test: $Z = -3.43$, $p = 0.0006$.

[j] Estimate range 0–7. Cronbach's alpha of the scale = 0.60.

[k] Estimate range 1–5.

[l] Estimate range 0–3.

[m] Estimate range 8–40.

[n] Estimate range 1–4.

[o] Variance of physical activity estimate in the pre-pandemic period was 1.16, whereas in the pandemic period 0.96.

medicines are harmful or overused did not change; indeed, such beliefs have previously been found to remain temporarily stable irrespective of changes in health status.[21] Similarly, Bush and Iannotti[22] found some other health behaviors and beliefs largely unchanged over time.

Interestingly, our findings suggest that consumption of DS did not significantly change over the pandemic period, which is inconsistent with market analysis reports suggesting a rise in DS purchase and use in this time.[9,10] This discrepancy may be an artefact of the studied population: the participants were users of an online health service and pharmacy, among whom as much as four fifths reported to use DS before the pandemic. These people may be regarded as "chronic DS users", irrespective of the situation, even the COVID-19 pandemic.

During the pandemic, the respondents expressed more pronounced beliefs that DS are well controlled in terms of quality, composition, efficacy and safety. Although the lockdown was characterized by far-reaching governmental control over the economy and society, this control did not extend to ensuring DS quality. Unfortunately, such misconceptions could occur as the pandemic state restrictions were generally well accepted in Poland.[23] However, it appears that stronger beliefs about DS quality control could not be attributed to public overall confidence in supplements,[24] as beliefs about DS efficacy in disease prevention were found to not change over the pandemic lockdown period.

In addition, the respondents reported having less contact with DS advertisements during the lockdown period than before; this would be in line with the reduction in DS advertising expenditure at this time.[25] Moreover, public attention turned to sanitary protective equipment rather than DS.[26]

During the lockdown, less variation in physical activity was observed than before, which contradicts the report by Lesser and Nienhuis.[27] According to the present findings, rural residents seemed to be more physically active during the lockdown. This is, however, likely a false positive result, representing the effect of seasonal shift from late winter to spring, in which rural residents are more engaged in physical activity associated with agricultural work.

This study has some limitations. First of all, the participants were recruited from a specific population of online health service users[14]; therefore, any generalization of the results to wider populations should be attempted with caution. Secondly, due to changes in social mood, the reported findings may not be replicated during other lockdowns related to the second COVID-19 wave or any other economic collapse. Thirdly, the applied research design is not capable of investigating *the effect* of pandemic lockdown. For example, the research outcomes could have been influenced by the change from late winter to spring, as discussed above with regard to physical activity. Moreover, although the analyses were controlled in terms of sociodemographic confounders, it is still possible that the participants during the pandemic differed from those from the pre-pandemic period in some other regard not covered in the present study, and hence any conclusions regarding the casual relationship can only be tentative. Fourthly, as the incidence of COVID-19 in Poland was relatively low during the first wave of the pandemic, it may not have resulted in dramatic changes in beliefs and behavior. Finally, self-reported declarative measures were used in the study, and hence there may have been some systematic error in the estimates, as indicated by the social desirability bias theory.[28]

Conclusions

Among Polish online health service users, the majority of examined medication-, dietary supplement- and health-related behaviors, beliefs and other psychological constructs remained unchanged in COVID-19 pandemic lockdown compared to the pre-pandemic time period. The pandemic period was characterized by more intense beliefs that the quality, composition, efficacy and safety of DS are well controlled, as well as less contact with advertisements for DS. The degree of variability in the research outcomes appeared insignificant over the pandemic lockdown with a possibly false positive effect regarding physical activity. Although the research report is preliminary and bears some methodological limitations, it may help understand some health-related issues in the time of pandemic lockdown and become the basis for shaping some aspects of health-related policy.

Author contributions

Conceptualization: MSK. Data curation: MSK. Formal analysis: MSK. Funding acquisition: MSK, EK. Investigation: MSK, MD, EP, RPK. Methodology: MSK. Project administration: MSK, EK. Resources: MSK. Software N/A,Supervision: MSK, EK. Validation: MSK. Visualization: MSK, MD. Writing - original draft: MSK, MD, EP, RPK. Writing - review & editing: MSK, MD, EP, RPK, EK.

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Declaration of competing interest

EP, a co-author of the study, has been employed in OSOM STUDIO, an e-marketing agency. The role of DOZ.pl Sp. z o.o. in the study was to prepare promotional materials to help recruit participants and to enter the survey content into an external online survey system. OSOM STUDIO and DOZ.pl Sp. z o.o. had no role in study design, data collection, analysis and interpretation, decision to publish, or preparation, review and approval of the manuscript.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.sapharm.2020.11.015.

References

1. Han E, Tan MMJ, Turk E, et al. Lessons learnt from easing COVID-19 restrictions: an analysis of countries and regions in Asia Pacific and Europe. *Lancet*. 2020;396 (10261):1525–1534. https://doi.org/10.1016/S0140-6736(20)32007-9.
2. Richards M, Anderson M, Carter P, Ebert BL, Mossialos E. The impact of the COVID-19 pandemic on cancer care. *Nat Can (Que)*. 2020;1(6):565–567. https://doi.org/10.1038/s43018-020-0074-y.
3. Tagliabue F, Galassi L, Mariani P. The "pandemic" of disinformation in COVID-19. *SN Compr Clin Med*. 2020:1–3. https://doi.org/10.1007/s42399-020-00439-1. Published online August 1.
4. Mertens G, Gerritsen L, Duijndam S, Salemink E, Engelhard IM. Fear of the coronavirus (COVID-19): predictors in an online study conducted in March 2020. *J Anxiety Disord*. 2020;74:102258. https://doi.org/10.1016/j.janxdis.2020.102258.
5. Blustein DL, Duffy R, Ferreira JA, Cohen-Scali V, Cinamon RG, Allan BA. Unemployment in the time of COVID-19: a research agenda. *J Vocat Behav*. 2020; 119:103436. https://doi.org/10.1016/j.jvb.2020.103436.
6. Barach P, Fisher SD, Adams MJ, et al. Disruption of healthcare: will the COVID pandemic worsen non-COVID outcomes and disease outbreaks? *Prog Pediatr Cardiol. Published online June*. 2020;6. https://doi.org/10.1016/j.ppedcard.2020.101254.
7. Mattioli AV, Sciomer S, Cocchi C, Maffei S, Gallina S. Quarantine during COVID-19 outbreak: changes in diet and physical activity increase the risk of cardiovascular disease. *Nutr Metabol Cardiovasc Dis*. 2020;30(9):1409–1417. https://doi.org/10.1016/j.numecd.2020.05.020.
8. Luo M, Guo L, Yu M, Jiang W, Wang H. The psychological and mental impact of coronavirus disease 2019 (COVID-19) on medical staff and general public – a systematic review and meta-analysis. *Psychiatr Res*. 2020;291:113190. https://doi.org/10.1016/j.psychres.2020.113190.
9. Wirus sprzyja suplementom. https://web.archive.org/web/20200702091042/https://www.rp.pl/Biznes/305199862-Wirus-sprzyja-suplementom.html. Accessed November 19, 2020.
10. Dietary supplement usage up dramatically during pandemic, new ipsos-CRN survey shows. https://web.archive.org/web/20200926081839/https://www.crnusa.org/

newsroom/dietary-supplement-usage-dramatically-during-pandemic-new-ipsos-crn-survey-shows. Accessed November 7, 2020.
11. Malik M, Tahir MJ, Jabbar R, Ahmed A, Hussain R. Self-medication during Covid-19 pandemic: challenges and opportunities. *Drugs Ther Perspect*. 2020:1–3. https://doi.org/10.1007/s40267-020-00785-z. Published online October 3.
12. Sahanic S, Boehm A, Pizzini A, et al. Assessing self-medication for obstructive airway disease during COVID-19 using Google Trends. *Eur Respir J*. 2020. https://doi.org/10.1183/13993003.02851-2020. Published online January 1.
13. de Faria Coelho-Ravagnani C, Corgosinho FC, Sanches FLFZ, Prado CMM, Laviano A, Mota JF. Dietary recommendations during the COVID-19 pandemic. *Nutr Rev*. 2020. https://doi.org/10.1093/nutrit/nuaa067. Published online July 12.
14. Karbownik MS, Horne R, Paul E, Kowalczyk E, Szemraj J. Determinants of knowledge about dietary supplements among Polish Internet users with no medical education: a nationwide cross-sectional study. *J Med Internet Res*. 2021, 25228. https://doi.org/10.2196/25228 (forthcoming).
15. Karbownik MS. Study protocol. *Determinants of Knowledge about and Use of Dietary Suppl.*; 2019. Published online October 21 https://osf.io/5e92d/. Accessed October 23, 2020.
16. Karbownik MS, Paul E, Nowicka M, et al. Knowledge about dietary supplements and trust in advertising them: development and validation of the questionnaires and preliminary results of the association between the constructs. *PloS One*. 2019;14(6), e0218398. https://doi.org/10.1371/journal.pone.0218398.
17. Pajor EM, Oenema A, Eggers SM, de Vries H. Exploring beliefs about dietary supplement use: focus group discussions with Dutch adults. *Publ Health Nutr*. 2017; 20(15):2694–2705. https://doi.org/10.1017/S1368980017001707.
18. Ajzen I, Joyce N, Sheikh S, Cote NG. Knowledge and the prediction of behavior: the role of information accuracy in the theory of planned behavior. *Basic Appl Soc Psychol*. 2011;33(2):101–117. https://doi.org/10.1080/01973533.2011.568834.
19. Horne R, Weinman J, Hankins M. The beliefs about medicines questionnaire: the development and evaluation of a new method for assessing the cognitive representation of medication. *Psychol Health*. 1999;14(1):1–24. https://doi.org/10.1080/08870449908407311.
20. Karbownik MS, Jankowska-Polańska B, Horne R, Górski KM, Kowalczyk E, Szemraj J. Adaptation and validation of the Polish version of the Beliefs about Medicines Questionnaire among cardiovascular patients and medical students. *PloS One*. 2020;15(4), e0230131. https://doi.org/10.1371/journal.pone.0230131.
21. Porteous T, Francis J, Bond C, Hannaford P. Temporal stability of beliefs about medicines: implications for optimising adherence. *Patient Educ Counsel*. 2010;79(2): 225–230. https://doi.org/10.1016/j.pec.2009.07.037.
22. Bush PJ, Iannotti RJ. Origins and stability of children's health beliefs relative to medicine use. *Soc Sci Med*. 1988;27(4):345–352. https://doi.org/10.1016/0277-9536(88)90268-7.
23. Centrum Badania Opinii Społecznej. Rząd wobec epidemii – oceny we wrześniu. Nr 120/2020. Published October https://web.archive.org/web/20201119093254/https://www.cbos.pl/SPISKOM.POL/2020/K_120_20.PDF; 2020. Accessed November 19, 2020.
24. Sirico F, Miressi S, Castaldo C, et al. Habits and beliefs related to food supplements: results of a survey among Italian students of different education fields and levels. *PloS One*. 2018;13(1). https://doi.org/10.1371/journal.pone.0191424.
25. W drugim kwartale bieżącego roku reklamodawcy wydali niemal o 1/3 mniej niż przed rokiem. *W całym półroczu spadek wydatków wyniósł 15,3%*; 2020. Portal PublicRelations.pl. Published August 27 https://web.archive.org/web/20201022114123/https://publicrelations.pl/publicis-groupe-w-drugim-kwartale-biezacego-roku-reklamodawcy-wydali-niemal-o-13-mniej-niz-przed-rokiem-w-calym-polroczu-spadek-wydatkow-wyniosl-15/. Accessed November 16, 2020.
26. Trendy Google. Google trends. https://trends.google.com/trends/explore?date=2020-02-01%202020-05-25&geo=PL&q=suplementy%20diety,witamina%20c,cynk,p%C5%82yn%20do%20dezynfekcji,maseczki. Accessed November 16, 2020.
27. Lesser IA, Nienhuis CP. The impact of COVID-19 on physical activity behavior and well-being of Canadians. *Int J Environ Res Publ Health*. 2020;17(11). https://doi.org/10.3390/ijerph17113899.
28. Latkin CA, Edwards C, Davey-Rothwell MA, Tobin KE. The relationship between social desirability bias and self-reports of health, substance use, and social network factors among urban substance users in Baltimore, Maryland. *Addict Behav*. 2017;73: 133–136. https://doi.org/10.1016/j.addbeh.2017.05.005.