Nutrition and Health (including climate and ecological aspects)

Advancing European nutrition – are pharmacists eligible partners in the process?

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Received: 1 July 2020 / Revised: 1 December 2020 / Accepted: 10 December 2020 / Published online: 2 February 2021
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Abstract
Background/Objectives Pharmacists may play an important role in disease prevention through the public education about dietary and lifestyle behaviors, however their expertise is constantly ignored. The study primarily aimed to identify nutrition knowledge and dietary habits among Polish pharmacists.

Subjects A total sample screened consisted of 1412 respondents, yet 667 (573 females and 94 males) pharmacists finally participated in the study. A validated questionnaire for Polish population, the Dietary Habits and Nutrition Beliefs Questionnaire, was used for the evaluation.

Results The majority of pharmacists (94%) were current non-smokers with BMI levels below 25 kg/m² (66.5%). Female pharmacists had higher the Pro-Healthy (pHDI-10) score (p < 0.001) and lower the Non-Healthy (nHDI-14) score (p = 0.004) compared to the males. In the self-assessment of nutritional habits, the pHDI-10 was significantly higher in the “very good” group compared to the “poor” (p < 0.001) and the “very poor” (p = 0.015) group, and the “poor” group had higher nHDI-14 when compared to “very good” (p < 0.001) and “good” (p < 0.001) groups. The nutrition knowledge test score was above average in over 72% of respondents, was correlated with the pHDI-10 (r = 0.16), yet the score decreased with age (r = −0.19).

Conclusions We believe that our analysis justifies the inevitability to benefit from pharmacists’ expertise. Pharmacists with around-the-clock accessibility should be eligible partners, as members of an interdisciplinary team, in the process of advancing population-based nutrition.

Introduction
Globally, death rates from non-communicable diseases (NCD) are increasing and could be partially attributed to inadequate nutrition and improper lifestyle. According to World Health Organization data, cardiovascular diseases account for most NCD deaths (17.9 million people annually) and are followed by cancers, respiratory diseases and diabetes. Modifiable behavioral risk factors, such as unhealthy dietary habits (including excess sodium daily intake), tobacco use, physical inactivity and the harmful use of alcohol, greatly increase the risk of dying from a NCD [1]. The consequent health burden arising from the nutrition transition towards increased consumption of more energy-dense food with less activity is enormous, yet preventable [2]. Nutrition knowledge remains an integral component of health literacy and low health literacy is usually associated with poor health outcomes [3]. Pharmacists, one of the largest and most accessible healthcare professionals [4–6], may globally play a critical role in disease prevention through the public education about those modifiable dietary and lifestyle behaviors. In addition, community pharmacies are often found in rural areas being sometimes the only point of contact patients have with a healthcare professional [7, 8].

Up-to-date, no study has been dedicated to comprehensively evaluate dietary and lifestyle decisions among European pharmacists. Therefore, the primary aim of our study was to identify dietary habits and nutrition knowledge in a sample of Polish pharmacists as well as to assess the relationship between their nutrition knowledge and diet quality together with lifestyle decisions. The Dietary Habits and
Nutrition Beliefs Questionnaire [9–11], a validated questionnaire for Polish population, was used for the evaluation.

Subjects and methods

Study sample, recruitment and data collection

The study protocol was approved by the Jagiellonian University Bioethics Committee (protocol number – 1072/6120/197/2017). The self-administered version of The Dietary Habits and Nutrition Beliefs Questionnaire (KomPAN) was available online (Jagiellonian University Medical College domain “ankiety.cm-uj.krakow.pl”) and was only addressed to Polish pharmacists with a valid licensure (an only inclusion criterion). According to the Central Registry of Pharmacists (2018), there were more than thirty-four thousand pharmacists in Poland. Information about the questionnaire was published on the Internet site of the Pharmacists’ Chamber of Lesser Poland and portal e-farmacja.pl, and was also included into newsletters to collect as many responses as possible. The study sample was recruited between May and October 2018.

A total sample screened consisted of 1412 respondents. In the preliminary analysis, respondents were excluded due to: (1) incomplete data (n = 647); (2) not meeting the age criterion – an age over 65 – for the questionnaire (n = 13); or (3) failed systemic verification of respondents’ reliability based on KomPAN manual guide (n = 85). Finally, 667 pharmacists participated in the study.

Diet quality, nutrition knowledge and lifestyle decisions

The self-administered version of the questionnaire was used to collect food frequency consumption, nutrition beliefs together with lifestyle and personal data (including weight, height and waist circumference as well as physical activity levels, sleeping time and smoking practices). Two diet quality scores: the Pro-Healthy Diet Index (pHDI-10) and the Non-Healthy-Diet Index (nHDI-14) together with lifestyle and personal data (including weight, height and waist circumference as well as physical activity levels, sleeping time and smoking practices). The ratio of calcium to phosphorus in a healthy diet should be 1:1. Phosphorus is a component of neural tissue. The ratio of calcium to phosphorus in a healthy diet should be 1:1. Phosphorus is a component of neural tissue.

Nutrition knowledge (Table 1) was evaluated using 25 statements with 3 response categories: true (1 point), false or unsure (0 points). The total nutrition knowledge score was calculated as a sum of points (the range: 0–25 points) and was categorized as follows: “insufficient” (0–8 points), “sufficient” (9–16 points), and “good” (17–25 points).

Table 1 The nutrition knowledge test according to the KomPAN questionnaire.

| Nutrition knowledge statements                                                                 | Score |
|---------------------------------------------------------------------------------------------|-------|
| It is enough to eat whole grains/cereals once a day.                                        |       |
| Only children and adolescents should drink milk.                                            |       |
| Fruit and/or vegetables should be consumed with every meal.                                 |       |
| Consumption of moldy bread can result in food poisoning caused by Salmonella.               |       |
| High intakes of salt protect from hypertension.                                            |       |
| Limiting high-fat foods in everyday diet is protective against cardiovascular diseases.     |       |
| Frequent consumption of oily fish contributes to atherosclerosis.                           |       |
| Frequent consumption of grilled meats contributes to the onset of cancer.                   |       |
| Vegetarian diet increases the risk of anemia.                                              |       |
| Bio-yogurts contain beneficial gut bacteria.                                                |       |
| Vegetable oils and olive oil contain a high amount of cholesterol.                         |       |
| Whole-meal bread has more fiber than white bread.                                          |       |
| Fruit and vegetables are a source of ‘empty calories’.                                      |       |
| Butter and fortified margarines have high content of vitamin A and D.                      |       |
| Cheese is a better source of calcium than cottage cheese.                                   |       |
| Offal has high amounts of ‘bad’ cholesterol - LDL.                                         |       |
| In a healthy diet, complex carbohydrates should be replaced with simple sugars.            |       |
| In a balanced diet, proteins should be the main source of energy.                           |       |
| Inadequate intakes of vitamin PP can cause skin inflammation and diarrhea.                 |       |
| Sun exposure increases the synthesis of vitamin D in the human body.                       |       |
| Phosphorus is a component of neural tissue.                                                 |       |
| The ratio of calcium to phosphorus in a healthy diet should be 1:1.                          |       |
| Consumption of fruit with high content of vitamin C increases bioavailability of iron.     |       |
| Starting cooking vegetables in cold water helps to preserve the nutrients.                 |       |
| Sweets and animal fats are particularly high nutrient dense foods.                          |       |

selected food items: (1) pHDI-10 included 10 food items representing pro-healthy food groups (the range between 0–20 points), and (2) nHDI-14 included 14 food items representing unhealthy food groups (the range between 0–28 points), and were converted to unify the total score range to a maximum of 100 points for each diet quality score.

Respondents were also asked to self-assess their nutrition knowledge and eating habits according to the following
**Table 2** Sample characteristics by socio-demographic and lifestyle variables according to age.

| Variables                                      | In total | Age |
|------------------------------------------------|----------|-----|
|                                                 |          | Below 30 | 31–40 | 41–50 | 51–60 | 60+ | p value |
| Number of subjects                             | 667 (100%) | 119 (17.8) | 241 (36.1) | 150 (22.5) | 121 (18.1) | 36 (5.4) | n/a |
| Gender (% of subjects)                         |          |          |       |       |       |     | 0.646 |
| Females                                        | 573 (85.9) | 101 (17.6) | 209 (36.5) | 129 (22.5) | 106 (18.5) | 28 (4.9) |       |
| Males                                          | 94 (14.1) | 18 (19.1) | 32 (34.0) | 21 (22.3) | 15 (16.0) | 8 (8.5) |       |
| Waist circumference (%)<sup>b</sup>            |          |          |       |       |       |     |       |
| Within normal range                            | 309 (46.3) | 67 (21.7) | 112 (36.2) | 71 (23.0) | 47 (15.2) | 12 (3.9) | <0.001 |
| Above normal range                             | 231 (34.6) | 24 (10.4) | 64 (27.7) | 64 (27.7) | 57 (24.7) | 22 (9.5) |       |
| No data                                        | 127 (19.0) |          |       |       |       |     |       |
| Current smoking                                |          |          |       |       |       |     |       |
| Yes                                            | 40 (6.0) | 7 (17.5) | 9 (22.5) | 9 (22.5) | 12 (30.0) | 3 (7.5) | 0.212 |
| No                                             | 627 (94.0) | 112 (17.9) | 232 (37.0) | 141 (22.5) | 109 (17.4) | 33 (5.3) |       |
| History of smoking                             |          |          |       |       |       |     |       |
| Yes                                            | 172 (25.8) | 23 (13.4) | 55 (32.0) | 39 (22.7) | 40 (23.3) | 15 (8.7) | 0.019 |
| No                                             | 495 (74.2) | 96 (19.4) | 186 (37.6) | 111 (22.4) | 81 (16.4) | 21 (4.2) |       |
| Sleep time on weekdays (hours/day)             |          |          |       |       |       |     |       |
| ≤6                                             | 167 (25.0) | 17 (10.2) | 64 (38.3) | 37 (22.2) | 40 (24.0) | 9 (5.4) | 0.110 |
| 7–8                                            | 492 (73.8) | 100 (20.3) | 174 (35.4) | 112 (22.8) | 79 (16.1) | 27 (5.5) |       |
| ≥9                                             | 8 (1.2) | 2 (25.0) | 3 (37.5) | 1 (12.5) | 2 (25.0) | 0 (0.0) |       |
| Sleep time on weekends (hours/day)             |          |          |       |       |       |     |       |
| ≤6                                             | 42 (6.3) | 3 (7.1) | 16 (38.1) | 9 (21.4) | 8 (19.0) | 6 (14.3) | <0.001 |
| 7–8                                            | 458 (68.7) | 67 (14.6) | 168 (36.7) | 103 (22.5) | 92 (20.1) | 28 (6.1) |       |
| ≥9                                             | 167 (25.0) | 49 (29.3) | 57 (34.1) | 38 (22.8) | 21 (12.6) | 2 (1.2) |       |
| Screen time (hours/day)<sup>b</sup>            |          |          |       |       |       |     |       |
| ≤2                                             | 65 (9.7) | 4 (6.1) | 27 (41.5) | 16 (24.6) | 13 (20.0) | 5 (7.7) | 0.014 |
| 2 to ≤4                                        | 86 (12.9) | 11 (12.8) | 26 (30.2) | 23 (26.7) | 19 (22.1) | 7 (8.1) |       |
| 4 to ≤6                                        | 109 (16.3) | 15 (13.7) | 32 (29.4) | 28 (25.7) | 27 (24.8) | 7 (6.4) |       |
| 6 to <8                                        | 169 (25.3) | 27 (16.0) | 66 (39.1) | 34 (20.1) | 33 (19.5) | 9 (5.3) |       |
| 8 to ≤10                                       | 176 (26.4) | 47 (26.7) | 70 (39.8) | 34 (19.3) | 19 (10.8) | 6 (3.4) |       |
| ≥10                                            | 62 (9.3) | 15 (24.2) | 20 (32.3) | 15 (24.2) | 10 (16.1) | 2 (3.2) |       |
| Recreational physical activity<sup>c</sup>     |          |          |       |       |       |     |       |
| Low                                            | 212 (31.8) | 40 (18.9) | 71 (33.5) | 40 (18.9) | 48 (22.6) | 13 (6.1) | 0.341 |
| Moderate                                       | 324 (48.6) | 56 (17.3) | 121 (37.3) | 80 (24.7) | 54 (16.7) | 13 (4.0) |       |
| High                                           | 131 (19.6) | 23 (17.6) | 49 (37.4) | 30 (22.9) | 19 (14.5) | 10 (7.6) |       |
| Type of water consumed                         |          |          |       |       |       |     |       |
| Still water                                     | 517 (77.5) | 105 (20.3) | 199 (38.5) | 106 (20.5) | 79 (15.3) | 28 (5.4) | <0.001 |
| Sparkling water                                | 142 (21.3) | 13 (9.15) | 48 (33.8) | 37 (26.1) | 36 (25.4) | 8 (5.6) | 0.003 |
| Flavored drink                                 | 16 (2.4) | 3 (18.8) | 3 (18.8) | 3 (18.8) | 7 (43.8) | 0 (0.0) | 0.065 |
| Do not drink water                             | 30 (4.5) | 5 (16.7) | 7 (23.3) | 8 (26.7) | 9 (30.0) | 1 (3.3) |       |

<sup>a</sup>Information regarding waist circumference (WC) was given voluntarily.

<sup>b</sup>Screen time was assessed using the question: “How many hours a day (on average) do you spend watching TV or using a computer (including work)?”

<sup>c</sup>Recreational physical activity was categorized as follows: low – mostly sedentary, watching TV, reading newspapers/book, light house works, walking for 1–2 h a week; moderate—walking, cycling, exercise, gardening, or other light intensity physical activity for 2–3 h a week; higher—cycling, running, gardening, or other sport activities that require physical activity for more than 3 h a week.

Questions: “How do you rate your nutrition knowledge?” (insufficient, sufficient, good, very good), “How do you rate your eating habits?” (very poor, poor, good, very good) and “How do you rate your diet during weekdays in comparison to weekends?” (no difference, unsubstantial difference, substantial difference).
Statistical analysis

The statistical analysis was performed simultaneously by two reviewers using Statistica 13 software (StatSoft, Kraków, Poland). The normality of variables was checked by Lilliefors test. As all analyzed distributions were non-normal (p < 0.05), non-parametric tests were used in the analysis. In comparisons of quantitative data either the Mann–Whitney or Kruskal–Wallis tests were applied. Respondents were divided into age groups based on the decade of life (below 30, 31–40, etc.) as well as BMI groups (underweight: BMI < 18.5; normal weight: BMI = 18.5–24.9; pre-obese: BMI = 25.0–29.9 and obese: BMI > 30.0) calculated based on voluntary information regarding weight and height (n = 650).

Results

Baseline data

The majority of respondents were females (85.9%), which has been representative for this health-care profession in Poland. The majority of respondents were current non-smokers (94.0%), while only the minority reported no alcohol consumption (18.6%). Moderate physical activity...
was reported by 48.6% respondents. Most of the pharmacists reported 7–8 h of sleep time during weekdays (73.8%) and weekends (68.7%; Table 2).

Body mass index (BMI) ≥ 25 was found in over 53% of males and 27% females, while too high waist circumference (above 80 cm and 94 cm in females and males, respectively) was reported by over 34% of pharmacists. The percentage of subjects classified as pre-obese or obese (based on BMI levels) exceed 50% in following age groups: 31–40, 41–50 and 51–60. Central obesity (based on waist circumference) was found especially in pre-obese and obese individuals. Socio-demographic and lifestyle data according to BMI is presented in Table 3. The variance of BMI with regard to recreational physical activity was statistically significant \( (p = 0.015) \), with BMI dropping with the rising level of physical activity. The significant variance was also found based on the amount of sleep time on weekdays \( (p = 0.026) \), with the mean BMI dropping with the increasing amount of sleep on workdays. The same relationship was observed between BMI and sleep time during weekends \( (p = 0.012) \). The mean BMI and percentage of pre-obese and obese individuals in our sample in comparison with Polish and European data (according to WHO data) are summarized in Table 4.

### Dietary patterns and nutrition knowledge

The mean values and the interquartile range of the Pro-Healthy Diet Index (pHDI-10), the Non-Healthy-Diet-Index (nHDI-14) and nutrition knowledge test score in comparison with Polish healthy population data \[8\] is contained in Table 5. Frequency consumption of selected food items, which were used to calculate the indexes, is also presented in Table 5. It is also worth mentioning that 33.1% respondents reported adding salt to meals. Table 6 shows differences in questionnaire scores between respondents with “good” (17–25 points) and “sufficient” (9–16 points) nutrition knowledge test. Only one individual yielded the “poor” below 9 points score and was not included in the analysis.

There were no sex-based differences in nutrition knowledge test score but females had higher pHDI-10 score \( (p < 0.001) \) and lower nHDI-14 score \( (p = 0.004) \) compared to the males. The pHDI-10 was only correlated with nutrition knowledge test score \( (r = 0.16) \). No differences in pHDI-10 and nHDI-14 were identified according to decades-based analysis. Statistical significance was noted for nutritional knowledge test score \( (p < 0.001) \), as the score decreased with age \( (r = -0.19) \). No significance between BMI level and pHDI-10 was found, but significant variance was found for nutrition knowledge test score \( (p = 0.002) \) and nHDI-14 \( (p = 0.041) \). Pharmacists with too high WC tended to have worse outcomes in nutrition knowledge test score \( (p = 0.031) \) and nHDI-14 \( (p < 0.001) \) compared to respondents with normal WC. The Pearson correlation test showed that BMI was not correlated with pHDI-10, but significantly correlated with nutrition knowledge test score \( (r = -0.15) \), nHDI-14 \( (r = 0.08) \), age \( (r = 0.32) \) and WC \( (r = 0.76) \). WC was significantly correlated with all variables: nutrition knowledge test score \( (r = -0.11) \), pHDI \( (r = -0.12) \), nHDI-14 \( (r = 0.18) \) and age \( (r = 0.25) \).

There was no relationship between alcohol intake and nutrition knowledge test score, nHDI-14 or pHDI-10 indexes. The mean values of pHDI-10 and nutrition knowledge test score were significantly \( (p = 0.004 \text{ and } p = 0.001, \text{respectively}) \) higher among deniers of current smoking compared to active smokers. While no significant association was found between the history of smoking, pHDI-10 and nHDI-14, the mean score of nutrition knowledge test was significantly higher among pharmacists without the history of smoking \( (p = 0.009) \).

Significant variance was found based on recreational physical activity: pHDI-10 \( (p < 0.001) \) and nutrition knowledge test score \( (p < 0.001) \) rose and nHDI-14 \( (p < 0.001) \) dropped proportionally to the rising intensity of recreational physical activity. In regard with sleep time, the only significant variance was found in nutrition knowledge test score \( (p = 0.007) \), with an average score rising with the ascending reported amount of sleep time during weekends.

### Nutrition knowledge and eating behaviors self-assessment

Respondents that self-reported lower nutritional knowledge (“Self-assessment of nutrition knowledge” - insufficient, integrated.
Table 5 The mean values and interquartile ranges (Q25–Q75) of consumption frequencies of the selected food items together with the Pro-Healthy Diet Index (pHDI-10), the Non-Healthy-Diet-Index (nHDI-14) and nutrition knowledge test scores in our sample in comparison with Polish healthy population data [7].

| Variables | Questionnaire results (n = 667) | Polish population data (n = 517) |
|-----------|---------------------------------|---------------------------------|
|           | Mean Q25–Q75                     | Mean Q25–Q75                     |
| **pHDI-10** |                                 |                                 |
| Whole-meal bread | 28.7 21.0–36.0                  | 24.9 15.6–31.3                  |
| Buckwheat, oats, whole grain pasta and other coarse-ground groats | 0.66 0.14–1.00 | 0.57 0.06–1.00 |
| Milk*     | 0.42 0.06–0.50                  | 0.25 0.06–0.50                  |
| Fermented milk beverages | 0.73 0.06–1.00                  | 0.68 0.14–1.00                  |
| Fresh cheese (cottage cheese) curd products | 0.47 0.14–0.50 | 0.5 0.14–0.50 |
| White meat products | 0.36 0.06–0.50                  | 0.39 0.06–0.50                  |
| Fish       | 0.38 0.14–0.50                  | 0.43 0.14–0.50                  |
| Pulse-based food products | 0.17 0.06–0.14                  | 0.16 0.06–0.14                  |
| Fruit      | 0.16 0.06–0.14                  | 0.13 0.06–0.14                  |
| Vegetables | 1.1 0.50–2.00                   | 0.96 0.50–2.00                  |
| **nHDI-14** |                                 |                                 |
| White bread | 15.3 9.5–20.0                   | 13.3 10.0–17.0                  |
| White rice, white pasta, fine-ground groats | 0.75 0.14–1.00 | 0.91 0.14–2.00 |
| Fast foods  | 0.29 0.06–0.50                  | 0.28 0.06–0.50                  |
| Fried foods | 0.06 0.06–0.06                  | 0.10 0.06–0.06                  |
| Butter, vegetable oils, margarines, mixes of butter and margarines | 0.27 0.06–0.50 | 0.35 0.14–0.50 |
| Cheese     | 0.81 0.06–1.00                  | 0.48 0.06–0.50                  |
| Lard (as an addition to bread or dishes, for frying, baking, etc.) | 0.04 0.00–0.06 | 0.46 0.14–0.50 |
| Cold meats, smoked sausages, hot-dogs | 0.45 0.14–0.50 | 0.05 0.00–0.06 |
| Red meat products | 0.52 0.14–0.50                  | 0.68 0.14–1.00                  |
| Sweets     | 0.28 0.06–0.50                  | 0.26 0.06–0.50                  |
| Tinned meat | 0.56 0.14–1.00                  | 0.69 0.14–1.00                  |
| Sweetened beveragesb | 0.01 0.00–0.00                  | 0.06 0.00–0.06                  |
| Energy drinks | 0.09 0.00–0.06                  | 0.32 0.06–0.50                  |
| Alcoholic beverages | 0.01 0.00–0.00                  | 0.12 0.00–0.06                  |
| **Nutrition knowledge**b | 17.8 16.0–20.0                  | 13.3 10.0–17.0                  |

*The consumption of skimmed and reduced-fat milk was reported by 2.3% and 44.7% respondents, respectively.

bThe minority of respondents (31.2%) reported sweetening of hot drinks.

cNutrition knowledge evaluation based on 25 questions (response categories: true, false, unsure) and assessed in 3 categories: insufficient (0–8 points), sufficient (9–16 points), good (17–25 points).

sufficient, good, very good) indeed yielded significantly worse results in the entire questionnaire – pHDI-10 (p < 0.001) and nHDI-14 (p = 0.001) as well as nutritional knowledge test score (p < 0.001).

In the self-assessment of nutritional habits (“Self-assessment of diet” - very poor, poor, good, very good) there was no significant variance in nutrition knowledge test score while significance was found when comparing pHDI-10 (p < 0.001) and nHDI-14 (p < 0.001) between groups. In post-hoc analysis the pHDI-10 was significantly higher in the “very good” group compared to the “poor” (p < 0.001) and the “very poor” (p = 0.015) group. In turn, the “poor group” had higher nHDI-14 when compared to “very good” (p < 0.001) and “good” (p < 0.001) groups.

Respondents whose self-reported nutritional habits differed substantially between workdays and weekends (“Self-assessment of diet during weekdays compared to weekend” - no difference, unsubstantial difference, substantial difference) had significantly lower pHDI-10 outcomes compared to pharmacists with the same diet on workdays and weekends as well as pharmacists who altered their diets slightly on weekends (p = 0.006). In nHDI-14 the difference was found between “slight differences” and “substantial differences” group, with the latter having significantly higher mean score (p = 0.049).

Discussion

To our knowledge, this is the first study to examine associations between a range of dietary and lifestyle behaviors as well as nutrition knowledge among Polish pharmacists. We used a validated, culture-specific, tool with reliable psychometric properties [9–11, 13–16]. Our results revealed that dietary patterns among this group of health-care professionals are moderate and comparable to the general adult Polish population [11], with slightly higher values of both, the Pro-Healthy Diet Index (pHDI-10) and the
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Non-Healthy-Diet-Index (nHDI-14). Importantly, the majority of respondents reported regular still water consumption, with a frequency of up to few times a day, and no adding salt to meals. The detailed analysis of the consumption frequencies of a priori selected food items, with regard to pHDI-10, revealed that vegetables are eaten more frequently by pharmacists (up to few times a day). In terms of the nHDI-14, in fact only the consumption of lard (as an addition to bread or dishes, for frying, baking, etc.) together with butter, vegetable oils, margarines, mixes of butter and margarines was reported more frequently in comparison to the general population, up to few times a week or once a day, respectively. Excessive consumption of dietary fats might indeed negatively impact human health, however frequent consumption of olive oil, for instance, is multidimensional and susceptible to underreporting bias [18]. No information regarding absolute quantities of consumption or cooking techniques could be provided using a qualitative food frequency questionnaire (FFQ) such as KomPAN either, which limits the interpretation of our study. The self-reported version is specifically prone to inaccuracy, and reported values from FFQs are subject to substantial error, both systematic (intake-related and person-specific) and random [19]. Not to mention the fact, that the length of the questionnaire might have lead to fatigue and boredom of our respondents’ and might have resulted in diminished sample size due to incomplete data, and likely reduced accuracy of the assessment [20, 21]. Thus, our analysis is only an illustration of some of the lifestyle trends among Polish pharmacists.

Moderate physical activity (2–3 h/week) and sleep time (7–8 h) as well as no history of smoking or current smoking were reported by the majority of respondents in all age groups, yet one-third of respondents were overweight or obese according to their BMI (especially in the forth decade of life). Age was positively correlated with elevated BMI and waist circumference. Importantly, the lower self-assessment of nutritional habits resulted in the higher nHDI-14 score, suggesting at least self-awareness. Pharmacists’ working schedule is inevitably connected with shift work, which might be a potentially detrimental factor to their nutrition quality [22, 23]. Shift duties in nurses, for instance, were positively associated with occurrence of abnormal eating [24]. A systematic review of relationship between circadian rhythm and obesity indeed proved shift work (especially night shifts) to be detrimental to health, and account for weight gain, coronary artery disease or metabolic syndrome [25]. Still, much attention has been paid to the physicians’ dietary patterns while studies dedicated to pharmacists’ eating habits are scarce.

No correlation between the nutrition knowledge test score and nHDI-14 was noted in our sample. Indeed, the relationship between what people know and what they do has indeed been considered “very weak” [26]. The discussion about defining the relationship between theory and practice goes back to the ancient times of Aristotle and Plato [27]. Nutrition knowledge does not guarantee satisfactory dietary habits. In a systematic review on the association between nutrition knowledge and dietary intake in adults based on cross-sectional and quasi-experimental, randomized clinical trials, Spronk et al. concluded that most studies present a weak association between nutrition knowledge and food consumption [3]. A study performed on 105 college students studying health-related subjects (including nutrition) revealed that, even when students thought they had good nutrition knowledge, the knowledge was not compatible with their nutrition habits [28]. And indeed, according to the knowledge-attitude-behavior model, knowledge might not produce positive and significant changes in eating behavior, and it is essential to

Table 6 The differences between groups with “good” (17–25 points) and “sufficient” (9–16 points) score in the nutrition knowledge test.

|                  | Good knowledge | Sufficient knowledge | p value |
|------------------|----------------|----------------------|---------|
|                  | No. of respondents | Mean ± SD | Median | No. of respondents | Mean ± SD | Median |
| Age              | 472             | 40.0 ± 10.2 | 38     | 194               | 44.1 ± 11.4 | 45     | <0.001 |
| BMI              | 464             | 23.4 ± 4.0  | 22.6   | 185               | 24.1 ± 4.2  | 23.8   | 0.033  |
| WC               | 387             | 79.8 ± 12.6 | 78.0   | 153               | 81.2 ± 11.4 | 80.0   | 0.057  |
| pHDI-10          | 472             | 29.6 ± 10.2 | 29.4   | 194               | 26.6 ± 10.7 | 25.7   | 0.003  |
| nHDI-14          | 472             | 15.4 ± 7.7  | 14.5   | 194               | 15.0 ± 7.3  | 13.8   | 0.582  |

BMI body mass index, WC waist circumference, pHDI-10 the Pro-Healthy Diet Index, nHDI-14 the Non-Healthy-Diet-Index.

*Information regarding weight, height and waist circumference was given voluntarily.

*One individual yielded the “poor” score and was not included in the analysis.
have a motivation/stimulus to make change occur [29]. However, self-awareness of the importance of healthy dietary habits is the first step in eating behavior refinement. Knowledge does not stimulate change but instead acts as an important tool when people desire to change, given that knowledge rarely anticipates a behavioral change [26]. Nutrition knowledge might be a factor that improves eating behavior but it is not the only determinant. Data regarding the nutritional status of certain populations and their level of nutrition knowledge remain limited, and the use of different assessment tools and scores, in addition to different variables, objectives, and sample sizes, hampers the analysis of the determining factors [30].

Some data indicates that more than a fifth of physicians recall receiving no nutrition education in medical school. Yet, despite the paucity of nutrition curriculum in medical school [31, 32], physicians are the most credible sources for dietary information according to patients. Obviously, inadequate knowledge has resulted in less patient education [33, 34]. According to Dietz et al. medical doctors are poorly prepared to address obesity. In addition to biases and unfounded assumptions about obese patients, absence of training in behavior-change strategies and scarce experience working within inter-professional teams impairs care of those patients [35]. In the contrary, in Poland (yet not universally across Europe [7]), thorough nutrition education is obligatorily included in a pharmacy curriculum. And indeed, the majority of our respondents had relatively good nutrition knowledge according to KomPAN but the score significantly decreased with age, which clearly emphasize the importance of nutrition education in life-long learning programs. Current attitudes officially underline the importance of nutrition in public health but a lack of confidence, knowledge and skills gaps affect nutritional practice in the community pharmacy settings [7]. Engagement of pharmacists as sources of ongoing monitoring and education for lifestyle modification is also limited due to patients’ lack of awareness or privacy concerns [36]. Thus, ideally, a collaborative service involving a primary care physician, a pharmacist and other health professionals would provide more holistic patient care [37]. Undoubtedly, the ongoing epidemiological crisis due to COVID-19 has distinctly demonstrated a need for the entire health workforce collaboration in all aspects of human health [6, 38].

Limitations

The self-reported dietary assessments, such as ours, are prone to underreporting bias [18] and errors, such as, for instance, a lack of absolute nutrient intake [19]. Thus, our results predominantly illustrate lifestyle trends among Polish pharmacists. Uneven number of male and female respondents might have made the statistical analysis less valid, however, such proportions are representative for this group of health-care providers in Poland and Europe [39]. The length of the questionnaire might have also lead to fatigue of our respondents’ and might have resulted in diminished sample size and a reduced accuracy of the assessment [20, 21]. A reduced length of the questionnaire might be taken into account to increase the response rate in future studies. What is more, an interest toward health evaluations is characteristic for people high in nutrition knowledge [40]. Thus, to reduce selection bias the questionnaire might be traditionally mailed with a cover letter and a pre-paid return envelope to a random sample of pharmacists obtained via the national registry. However, such approach, due to the European Union General Data Protection Regulation, might be associated with administrative obstructions. Still, the results are of great importance in the process of improving long-lasting nutrition care, particularly in Eastern Europe.

Shift work or lack of time, which were not assessed in the study, may serve as potentially detrimental factors to pharmacists’ nutrition quality [22, 23]. While nutrition knowledge is not an exclusive determinant of eating behaviors, it remains fundamental for fruitful nutrition education. However, legislative or administrative barriers critical for the successful implementation of nutrition care into pharmacists’ daily routine were not assessed either. Nor were their communications skills needed to foster effective partnerships with other health-care provides.

Conclusions

Pharmacists, with around-the-clock accessibility and health knowledge, should be able to overstep their traditional function of dispensing and distributing medicines, and provide population-based nutrition care particularly related to chronic conditions. We believe that our analysis justifies and strengthens the inevitability to benefit from pharmacists’ expertise to comprehensively improve the quality of care outcomes achieved by health care systems, and yes, pharmacists indeed should be eligible partners in this process.

Acknowledgements Authors wish to thank all the respondents who participated in this study. In addition, authors would like to acknowledge Professor Lidia Wądołowska from the University of Warmia and Mazury in Poland, for her contribution regarding the analysis of the Dietary Habits and Nutrition Beliefs Questionnaire.

Author contributions MKŁ, KG were responsible for the conception and study design; MKŁ, ERD, KG were responsible for data collection; MKŁ, PP, PL were responsible for the data cleaning and statistical analysis; MKŁ, PP, PL were responsible for drafting the manuscript; MKŁ, PP, PL, ERD, KG were responsible for revising the manuscript critically for important intellectual content. All authors
approved the final version of the manuscript has been revised by all co-authors.

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

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