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ORIGINAL ARTICLE

HEALTHCARE PROFESSIONALS' KNOWLEDGE OF PROBIOTICS, PREBIOTICS, AND THE GUT MICROBIOTA – THE CITY OF KÉNITRA, MOROCCO: A PILOT STUDY

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ABSTRACT

Background. In scientific literature, it is relatively rare to find information on healthcare professionals' current knowledge of probiotics, prebiotics, and gut microbiota.

Objective. The aim of our study was to assess healthcare professionals' knowledge of gut microbiota, probiotics, and prebiotics in the city of Kénitra, Morocco.

Materials and Methods. The data was collected via an online questionnaire, which we distributed through social media. A total of 143 healthcare professionals (78.3% women and 21.7% men) responded to this questionnaire. The questionnaire concerned knowledge of probiotics and prebiotics.

Results. Most respondents rated their knowledge of probiotics, prebiotics, and gut microbiota as average (40%) or poor (39%), while others rated their knowledge as good (11%) and only 2% had very good knowledge, with the remainder (8%) having no knowledge. The correct definition of probiotics chose 67.1% of respondents, broken down as follows: 80.4% of general practitioners, 76.9% of specialists, and 57% of nurses. *Lactobacillus acidophilus* (65%) and *Bifidobacterium bifidum* (50.3%) are the two species best known to respondents as probiotic strains. Furthermore, the most popular prebiotic is fructooligosaccharide (51%), followed by galactooligosaccharide (42.7%) then inulin (36.4%) and finally beta-glucan (14%). Among professionals 60.1% prescribed probiotics and/or prebiotics for diarrhea, followed by antibiotics (47.6%) then constipation (39.2%) and 21% of respondents recommended them for diabetes, 18.9% for obesity while only 3.5% used them for other pathologies.

Conclusion. This online survey revealed the current knowledge of healthcare professionals regarding probiotics, prebiotics and gut microbiota and highlights the importance of educating and training them through targeted learning programs.

Keywords: *probiotics, prebiotics, gut microbiota, healthcare professionals, knowledge, Morocco*

INTRODUCTION

The microorganisms colonizing the digestive tract were formerly called "intestinal flora", but in the early 1990s this term was replaced by intestinal microbiota after Carl Woese proposed a new classification of the kingdom of life [1]. Bacterial colonization of the gastrointestinal tract begins at birth and this colonization and the composition of the gut microbiome can be influenced by many criteria, such as the mode of delivery: in the case of a caesarean birth, the acquisition of the usual dominant bacterial species is delayed compared with a vaginal birth. Several studies have shown that breastfeeding can act as a vector for microorganisms from the mother to the newborn. Other factors can also be added; such as place of birth, diet and antibiotic therapy, which could play a role in disrupting bacterial colonization [2]. The intestinal microbiota is a highly complex ecosystem, consisting of around 10^{14} bacteria as well as other microorganisms such as viruses, archaea and fungi. *Firmicutes*, *Bacteroidetes*, *Proteobacteria* and *Actinobacteria* are the four dominant bacterial phyla of the intestinal microbiota, with 60% to 75% represented by *Firmicutes* and 30% to 40% by *Bacteroidetes* [3]. The taxon composition (genus and/or major phylogenetic groups) is the same for all individuals, but the diversity of species dominating the gut microbiota is unique and constitutes a specific fecal imprint for each individual [4]. The intestinal microbiota plays a crucial role in the recovery of energy from food, as bacteria degrade and ferment

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undigested food, providing low-molecular-weight molecules such as succinate, pyruvate and lactate, and short-chain fatty acids such as butyrate, propionate and acetate which are used by colonocytes [5], thus acting as a barrier against colonization by pathogenic bacteria and contributing to the development and maturation of the intestinal immune system [6].

The progress and evolution of techniques for analyzing the intestinal microbiota have led to the discovery of interesting relationships between microbiota-health-pathologies, linking an increasing number of pathologies to disturbances of the intestinal ecosystem. These relationships have opened the way to the potential interest of a preventive or therapeutic approach by modulating the microbiota and/or its functions with pro- or prebiotics [7]. At the beginning of the 20th century, Metchnikoff was the first to initiate work on the health benefits of lactic acid bacteria in fermented milks. His research has been described as groundbreaking in the field of probiotics. In 2001, the World Health Organization (WHO) and the United Nations Food and Agriculture Organization (FAO) defined probiotics as "living microorganisms which, when ingested in adequate quantities, confer a health benefit on the host".

This definition was subsequently reaffirmed by the International Scientific Association for Probiotics and Prebiotics (ISAPP) in 2014. The ISAPP consensus document clarified that probiotics must be identified by strain and have validated effects, thereby distinguishing probiotic products from generic fermented foods [8].

The observed benefits of probiotics are regulation of intestinal transit, production of beneficial bacterial metabolites and competitive exclusion of pathogens. However, some strains may have specific effects such as vitamin synthesis, reinforcement of the intestinal barrier and an action on the metabolism of bile acids and/or certain enzymatic activities [9]. Some probiotics are able to increase lactose excretion in lactase-deficient adults, mainly due to the addition of bacterial-derived lactase intra luminally and some others can alleviate symptoms in patients suffering from irritable bowel syndrome [10]. Dietary carbohydrates that escape digestion in the upper digestive tract are substrates for colonic bacterial growth [11]; many dietary carbohydrates are classified as prebiotics. The FAO/WHO defines prebiotics as "a substrate that is selectively utilized by host microorganisms and confers a health benefit" [12]. This definition broadens the scope to include non-carbohydrate substances and sites in the body other than the gastrointestinal tract, while emphasizing the need for scientific evidence of beneficial effects. Prebiotics must meet certain criteria: 1) they must not be hydrolyzed either in the stomach or in the small intestine; 2) they must be selective for commensal colonic bacteria, promoting the growth and metabolism of organisms; 3) they must modify the composition of the microflora for a healthy composition; 4) they must induce beneficial effects in the host [13]. Several studies have demonstrated the efficacy of probiotics in the treatment of obesity and insulin resistance and type 2 diabetes, as well as gastrointestinal disorders and allergic conditions [14]. The limited number of studies that have been carried out to assess the perceptions and knowledge of healthcare providers have highlighted that healthcare professionals have limited knowledge of probiotics [15].

To date in Morocco there has been no study of healthcare professionals' perceived knowledge of intestinal microbiota, probiotics and prebiotics. The aim of this article was therefore to assess healthcare professionals' knowledge of intestinal microbiota, probiotics and prebiotics in the the city of Kénitra, Morocco.

MATERIAL AND METHODS

Study design and population

This pilot study was carried out among 143 healthcare professionals in the city of Kénitra over a three-month period from March 2025 to May 2025, aiming to assess their level of knowledge about gut microbiota, probiotics and prebiotics.

Data collection

We collected data using an online questionnaire that was distributed via social networks and sent to email addresses using snowball sampling. The survey questionnaire had two parts to collect the following data: 1 – epidemiological characteristics of respondents (age, type of profession, sector of activity), 2 – concerns various questions on the assessment of knowledge about intestinal microbiota, probiotics and prebiotics. The questions were modelled on those used in previous studies [16-18].

Participants were first asked to rate their knowledge of prebiotics and probiotics on a 5-point Likert scale, then asked questions about the definition of probiotics and prebiotics [19]. Participants were then asked to select the correct statements on intestinal microbiota and dietary fiber fermentation products, and were then asked whether they had ever prescribed probiotics and/or prebiotics to patients, and in which pathology. Finally, participants were asked to identify their sources of information on intestinal microbiota, probiotics and prebiotics.

Ethical considerations

The study protocol was previously approved by the ethics committee of provincial health and social protection delegation – Kénitra (N 1563/2025).

Statistical analysis

We collected all results online via Google Forms, and then data analysis was entered and carried out using SPSS version 25 software. Qualitative variables were expressed as percentages, while quantitative variables were presented as means and standard deviations. The Kruskal-Wallis test and the Mann-Whitney test were used to assess the total score for knowledge of probiotics, prebiotics and gut microbiota between the different groups of healthcare professionals.

The threshold of statistical significance was set at $p < 0.05$.

RESULTS

Sociodemographic characteristics of the study population

The sociodemographic characteristics of the study population are presented in Table 1. A total of 143 healthcare professionals from the city of Kénitra, Morocco completed the questionnaire. The mean age of respondents was 43.78 ± 12.25, ranging from 22 to 72 years. Women accounted for 78.3% of respondents, compared with 21.7% of men. Nurses were the main contributors to the study (55.2%), followed by general practitioners (GPs) (35.7%), while medical specialists and dieticians represented 9.1%. The percentage of healthcare professionals practicing in urban areas was 86.7%, compared with 13.3% in rural areas. The percentage of respondents working in the public sector was 82.5% vs. 17.5% in the private sector.

Table 1. Sociodemographic characteristics of the study population

Variable		Mean ± SD	Percentage
Age		43.78 ± 12.25	-
Gender	Woman	-	78.3%
	Man	-	21.7%
Profession	General practitioner	-	35.7%
	Dietitian	-	9.1%
	Nurse	-	55.2%
Environment	Urban	-	86.7%
	Rural	-	13.3%
Sector	Public	-	82.5%
	Private	-	17.5%

Self-assessment of respondents' knowledge of probiotics, prebiotics and intestinal microbiota

Most respondents rated their knowledge as average (40%) or little knowledge (39%), others rated their knowledge as good (11%) and only 2% had very good knowledge, while the remainder (8%) had no knowledge at all. Healthcare professionals rated their knowledge with a median score of 3, and the self-assessment was statistically similar between the two genders of the professional ($p = 0.869$) (Figure 1).

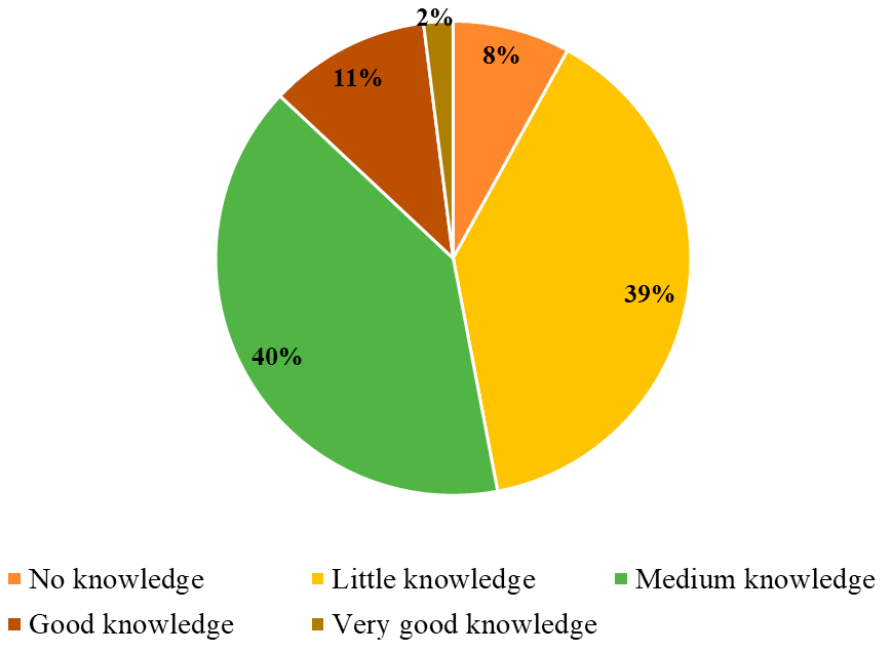


Figure 1. Self-evaluation of respondents' knowledge of probiotics, prebiotics and intestinal microbiota

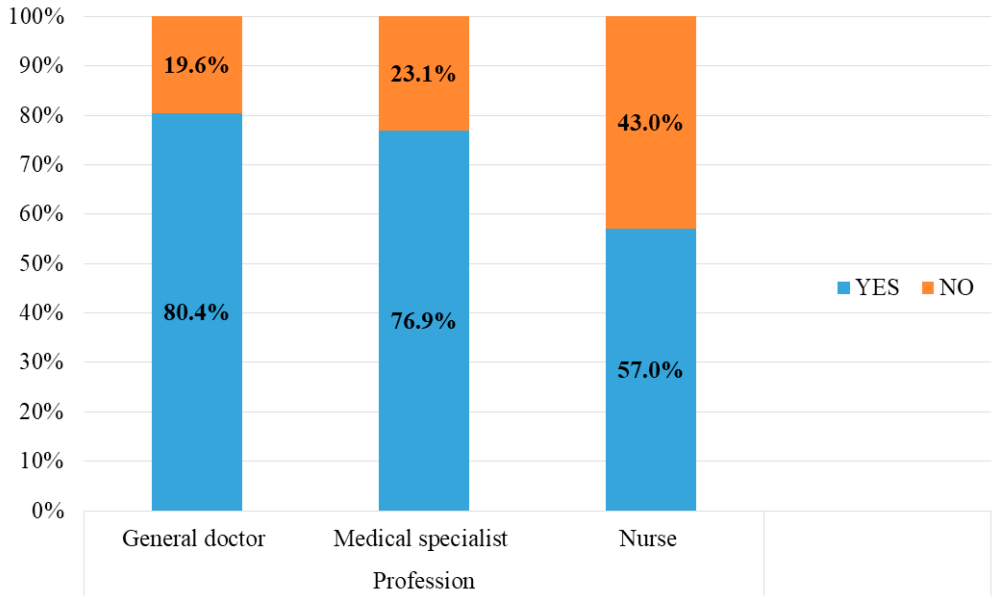


Figure 2. Knowledge of the correct definition of probiotics

Knowledge of the correct definition of probiotics

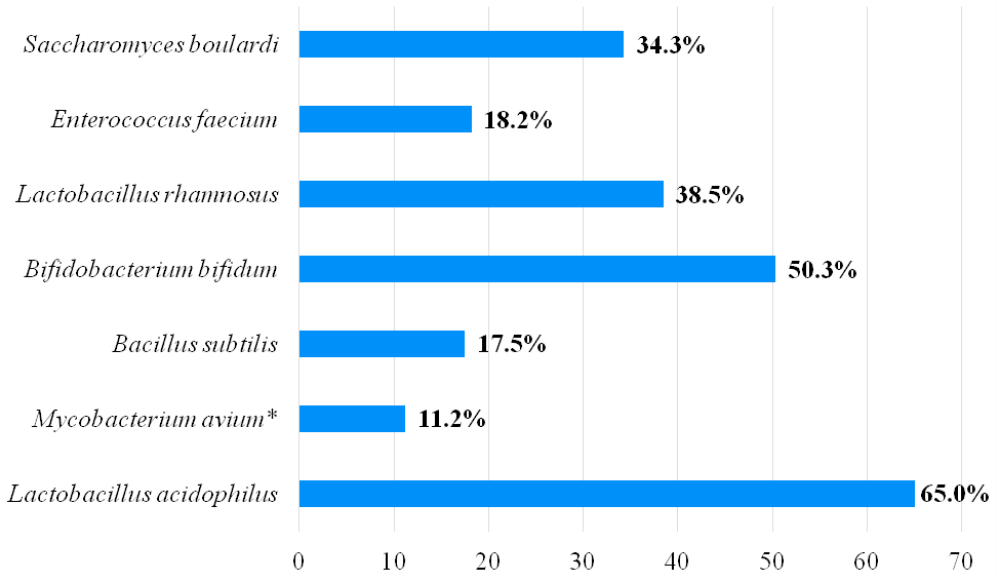
Figure 2 shows awareness of the correct definition of probiotics among different groups of healthcare professionals. Among respondents 67.1% chose the correct definition of probiotics, distributed as follows: 80.4% of general practitioners, 76.9% of specialists and 57% of nurses. There was a statistically significant relationship between profession and choice of the correct definition of probiotics ($p = 0.016$).

Respondents' knowledge of microbial species

Lactobacillus acidophilus (65%) and *Bifidobacterium bifidum* (50.3%) were the two species most familiar to respondents as probiotic strains, followed by *Lactobacillus rhamnosus* (38.5%), *Enterococcus faecium* (18.2%) and *Bacillus subtilis* (17.5%). Indeed, 11.2% of participants answered incorrectly, choosing *Mycobacterium avium* (Figure 3).

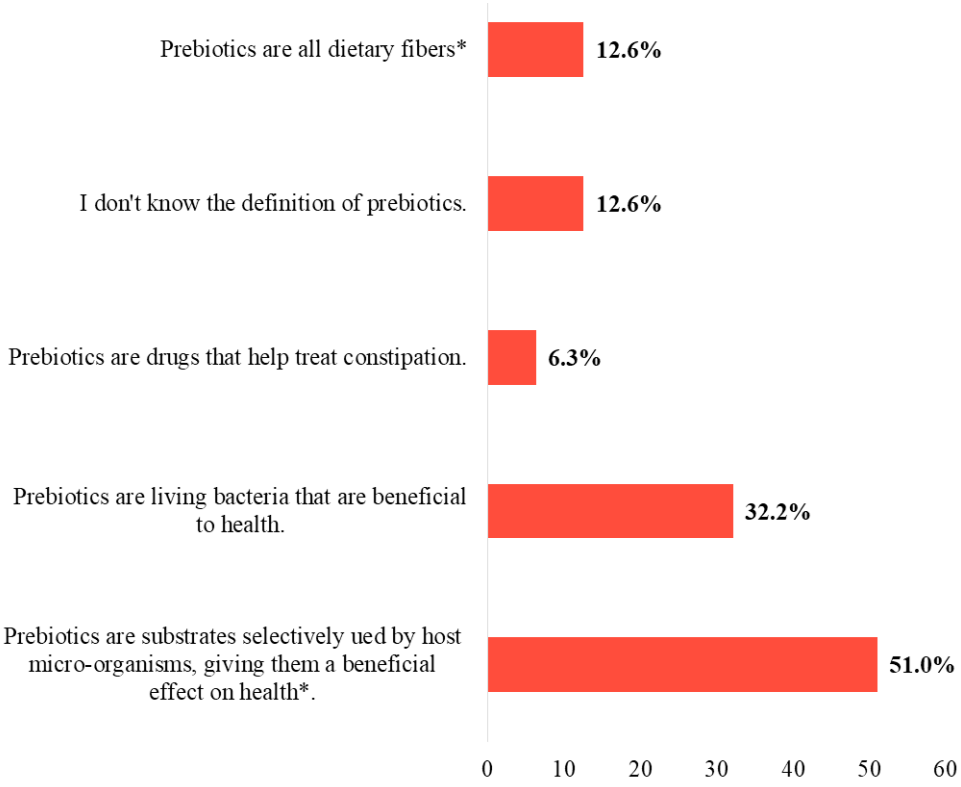
Respondents' knowledge of the correct definition of prebiotics

Respondents' knowledge of the correct definition of prebiotics is shown in Figure 4. The correct answers (answers 1 and 5) were chosen respectively by 51% and 12.6% of healthcare professionals, while 32.2%



*This species has no probiotic strains.

Figure 3. Respondents' knowledge of microbial species that possibly have probiotic strains

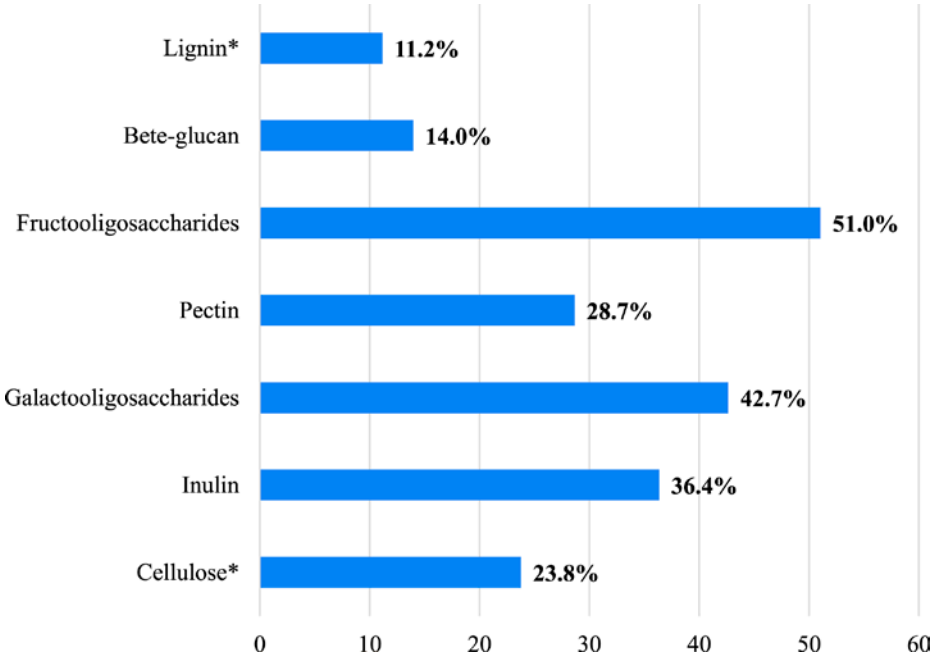


*These statements are correct.
Figure 4. Respondents' knowledge of the correct definition of prebiotics

of respondents ticked statement 4 which said that prebiotics are living bacteria, and 6.3% of professionals chose statement 3 ("Prebiotics are medicines that help treat constipation"). However, 12.6% did not know the definition of prebiotics. Among men, only 7.1% checked off the two correct choices of prebiotics, compared with 3.2% among women.

Respondents' knowledge of prebiotic types

Two of the options given were incorrect: lignin and cellulose; 23% of participants chose cellulose and 11.2% lignin. The most popular prebiotic was fructooligosaccharide (51%), followed by galactooligosaccharide (42.7%) then inulin (36.4%) and lastly beta-glucan (14%). Among women 4.5%



*These fibers are not prebiotics.
Figure 5. Respondents' knowledge of prebiotic types

ticked all the right answers, compared with 3.2% of men. Only 4.8% of urban health professionals ticked all the correct answers, versus 0% of rural professionals (Figure 5).

Respondents' knowledge of the intestinal microbiota

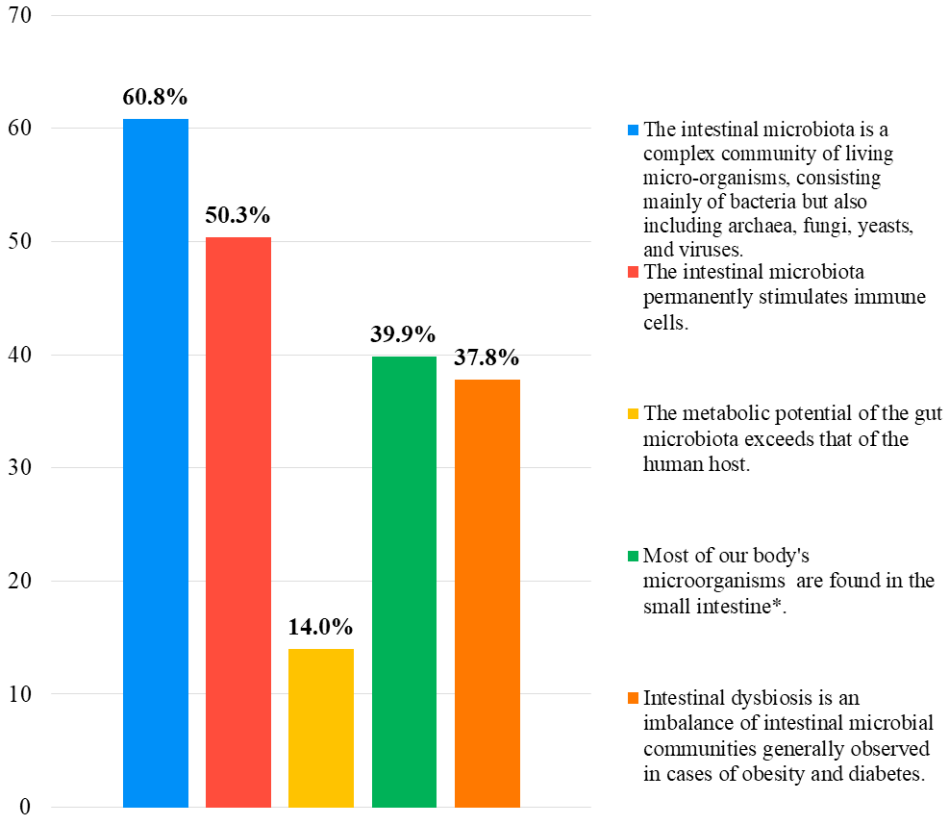
Only one of the five statements was false ("Most of our body's microorganisms are found in the small intestine") and 39.9% of participants ticked this statement as correct, while 60.8% ticked the answer "The intestinal microbiota is a complex community of living microorganisms, consisting mainly of bacteria but also archaea, fungi, yeasts and viruses", 50.3% chose the answer "The intestinal microbiota permanently stimulates immune cells", and 37.8% chose the answer "Intestinal dysbiosis is an imbalance of intestinal microbial communities generally observed in cases of obesity and diabetes" and only 14% of professionals ticked the answer "The metabolic potential of the intestinal microbiota exceeds that of the human host" (Figure 6). Among men, 6.5% selected all the correct answers, compared with 0% of women. The *Chi*-square test ($p = 0.007$) shows a statistically significant difference between men and women for this answer. Only 1.6% of urban professionals selected all the correct answers, compared with 0% of rural professionals.

Respondents' knowledge of the impact of diet on intestinal microbiota

The impact of diet on intestinal microbiota is shown in Figure 7. All choices are correct except the following: "Western diet and lifestyle are associated with a diverse gut microbiota". More than half of the participants (64.3%) selected the answer "The more diversified the diet, the more diversified the gut microbiota", 45.5% selected the answer "The adoption of different long-term diets results in different gut microbiota profiles", 24.5% ticked the answer "Dietary carbohydrates are the main drivers of gut microbiota characteristics", and 29.4% chose the answer "Dietary changes can lead to changes in gut microbiota within 24 hours"; and 26.6% of respondents chose the wrong answer. Among women, 3.6% ticked all the correct answers, compared with 6.5% of men.

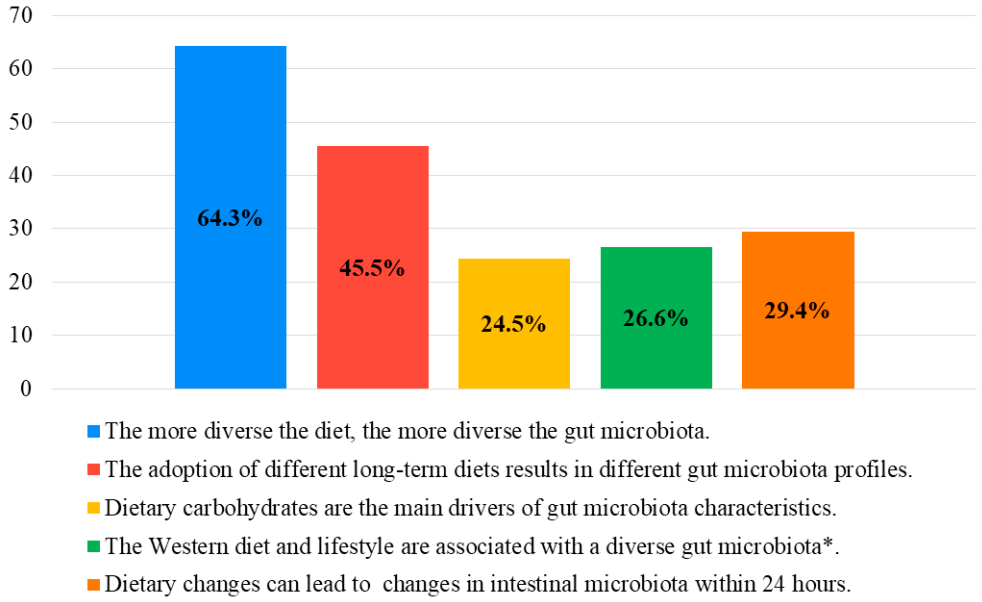
Respondents' knowledge of short-chain fatty acids

Respondents' knowledge of short-chain fatty acids is shown in figure 8. Approximately half (51%) chose acetate, 36.4% – propionate, 28% – butyrate, 26.6% – capric acid and only 11.9% – leucine. Among women, only 14.3% opted for all three correct answers and among men 12.9%. The percentage of urban professionals who ticked all the correct answers was 15.3%, compared with 5.3% in the rural group.

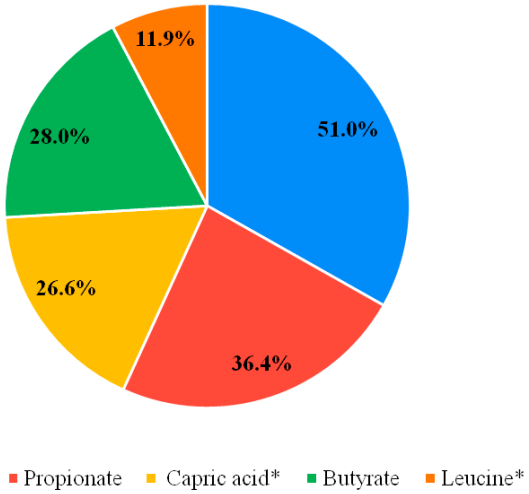


*This statement is false.

Figure 6. Respondents' knowledge of the intestinal microbiota



*This answer is false.
Figure 7. Respondents' knowledge of the impact of diet on intestinal microbiota



*These two chemical compounds are not short-chain fatty acids.
Figure 8. Respondents' knowledge of short-chain fatty acids

Respondents' knowledge of the role of short-chain fatty acids in glucose homeostasis

From the respondents' answers, we noted that 49% of healthcare professionals ticked the answer "By increasing intestinal hormone secretion and gluconeogenesis", 32.9% chose the answer "By providing energy to the colonocytes", and 28% opted for answer "By regulating the host's immune system" and only 25.9% chose answer "By reducing intestinal permeability" (Figure 9). The percentage of women who ticked all the correct answers was 3.6% vs. 6.5% in the men's group. The percentage of urban healthcare professionals who ticked all the correct answers was 4%, compared with 5.3% in rural areas.

Prescribing probiotics/prebiotics to patients

The prescribing of probiotics and/or prebiotics by respondents is shown in Figure 10. Most of them (79%) said "yes", against 21% who said "no".

Use of probiotics and/or prebiotics

Most of professionals (60.1%) prescribed probiotics and/or prebiotics for diarrhea, followed by antibiotics (47.6%) then constipation (39.2%) and 21% of respondents recommended them for diabetes, 18.9% for obesity, while only 3.5% used them for other pathologies (Figure 11).

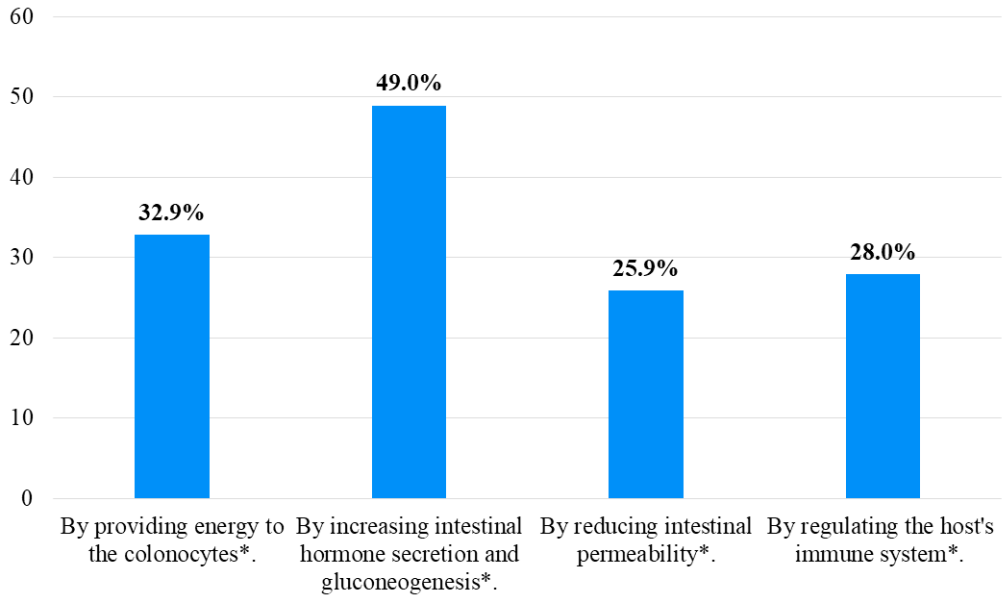
Source of knowledge about probiotics, prebiotics and intestinal microbiota

The purpose of this question is to find out what the participants' source of information is 65.7% of respondents rely on information from websites and 25.2% get their knowledge from university courses, while 21.7% rely on specialist journals (Figure 12).

Total respondent score calculated based on number of correct answers

A total respondent score was calculated based on the number of correct answers that were ticked out of all correct answers to eight questions (Q6 to Q13) on probiotics, prebiotics and the gut microbiota. The mean score was 40.60 reflecting a low score, with a high standard deviation (18.32) indicating variability between participants.

The total score obtained by the healthcare professionals was represented graphically by a moustache box; which revealed that the scores of general practitioners are homogeneous and higher



*These statements are correct.
Figure 9. Respondents' knowledge of the role of short-chain fatty acids in glucose homeostasis

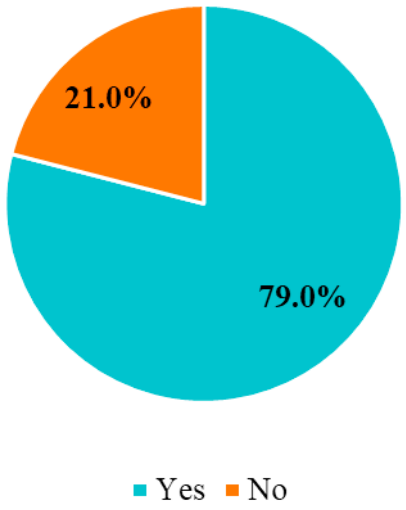


Figure 10. Respondents' use of probiotics and/or prebiotics

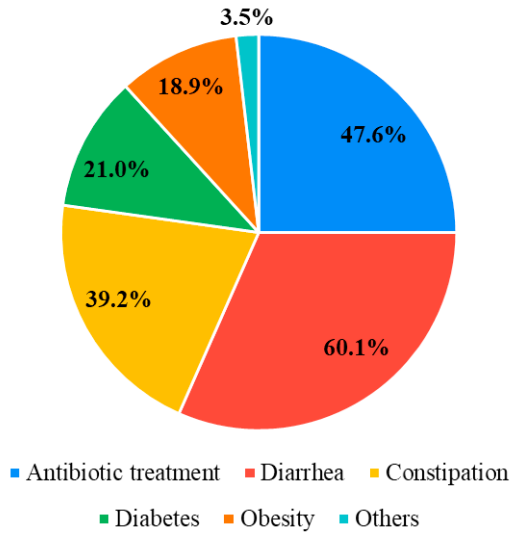


Figure 11. Distribution of pathologies for which respondents use probiotics and/or prebiotics

compared to specialist doctors and nurses. The box is stretched upwards in the nurses' category, attesting to an asymmetrical distribution, with extreme values in the same category reflecting a certain dispersion. The normality test (Kolmogorov-Smirnov and Shapiro-Wilk), as well as the Q-Qplot visualization, did not lead to the conclusion with certainty of the normality of distribution, so we opted for the non-parametric Kruskal-Wallis test to compare scores between professional categories. The Kruskal-Wallis test showed a statically significant difference in total score between the different groups of professionals ($p = 0.0$). This significant difference justifies pairwise comparisons. The Mann-Whitney test showed a significant difference in scores between general practitioners and nurses ($p = 0.0$) in favor of general practitioners, and scores differed significantly between specialist doctors and nurses ($p = 0.07$). There was no significant difference between GPs and specialists ($p = 0.565$) (Figure 13).

DISCUSSION

Various studies in different regions and professional categories have examined the perception and assessment of healthcare professionals' knowledge of intestinal microbiota, probiotics and prebiotics. These studies reveal the current state of knowledge, attitudes and practices of healthcare professionals, shedding light on gaps and strengths in their knowledge.

This pilot study was conducted among 143 healthcare professionals in the city of Kénitra. Although the small number of respondents in our sample limits the generalizability of the results, it nevertheless allows us to identify significant

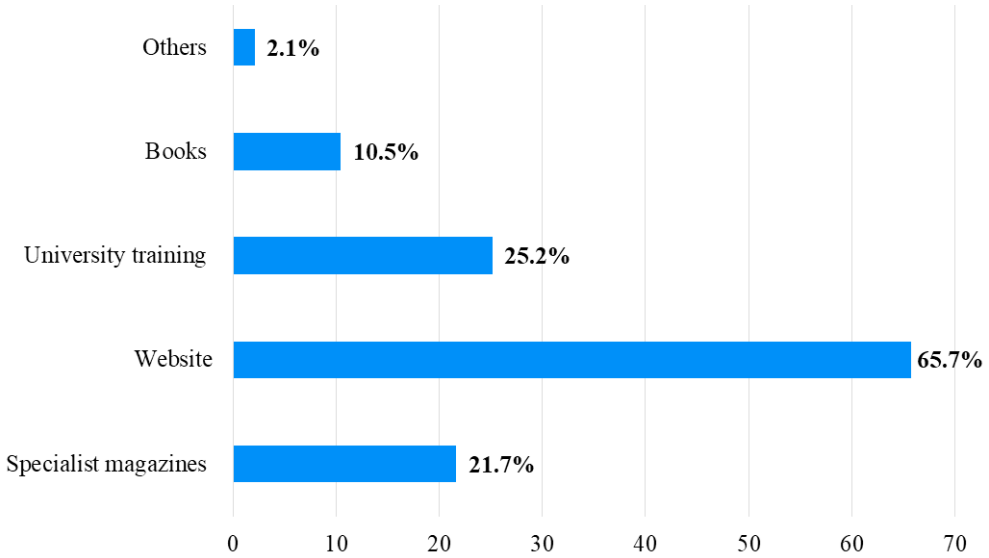


Figure 12. Respondents' sources of information on probiotics, prebiotics and gut microbiota

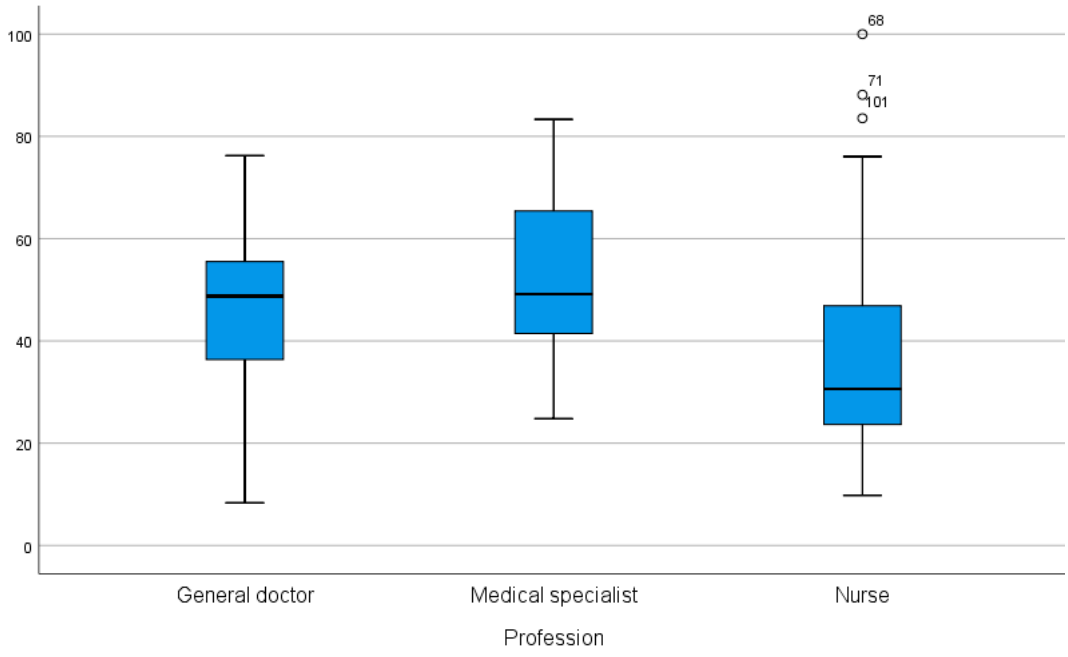


Figure 13. Total score of respondents

preliminary trends that warrant further investigation in future research. Our study showed that the average age of the participants was 43.78 ± 12.25 years. The majority of healthcare professionals rated their knowledge as either "average" or "limited". They rated their knowledge with a median score of 3, and the self-assessment was statistically similar between the two genders of the professional ($p = 0.869$). In the same vein, a study of European dieticians revealed that actual knowledge of probiotics and prebiotics was relatively low, while most participants perceived their knowledge as average to good. In addition, over 78% rated their knowledge of intestinal microbiota as average to good; however, actual knowledge of probiotics and prebiotics was low [17]. A survey of healthcare professionals in Pakistan revealed poor knowledge and practice of probiotics and prebiotics, with only 15.1% having good knowledge [20].

Our survey revealed that 67.1% of respondents chose the correct definition of probiotics and there was a statistically significant relationship between profession and choice of the correct definition of probiotics ($p = 0.016$). As many as 80.4% of general practitioners, 76.9% of specialist physicians and 57% of nurses chose the correct definition of probiotics. Moreover, *Lactobacillus acidophilus* and *Bifidobacterium bifidum* were the two species best known to respondents with probiotic strains, and a minority of participants chose *Enterococcus faecium* and *Bacillus subtilis*. In the same vein, a study carried

out in Mexico showed that the FAO definition of probiotics is recognized by 71% of gastroenterologists, and the majority of health professionals had gaps in detailed knowledge of probiotic strains [21]. Similarly, according to the results of a survey conducted in Iraq showed that 92.9% of respondents knew the definition of probiotics [22]. Related to this, a study conducted in Iraq highlighted good knowledge of probiotics among healthcare professionals such that 93.25% of participants were familiar with the term "probiotics" and 80.8% were able to accurately define probiotics [23]. Similarly, one study reported that the probiotic species *Lactobacillus acidophilus*, *Bifidobacterium bifidum* and *Lactobacillus rhamnosus* were best identified (respectively 92%, 82% and 62%) by respondents as strain-containing probiotics, while *Enterococcus faecium* (29%), *Saccharomyces boulardi* (27%), *Escherichia coli* (25%), were the least recognized as containing probiotic strains, while a minority of participants (4%) incorrectly selected *Mycobacterium avium* which is not a probiotic strain [16].

It should be noted that *Enterococcus faecium* and *Bacillus subtilis* are the subject of scientific debate regarding whether they can be considered as a strains probiotics. Although they are widely used and recognized for their benefits, they do not enjoy the same automatic safety status as other more traditional strains [24]. These two microorganisms meet the WHO definition, and their beneficial effects include *Enterococcus faecium*: Widely used to treat diarrhea and balance microbiota, it produces bacteriocins that inhibit pathogens; *Bacillus subtilis*: Valued for its ultra-resistant spore form, it promotes the growth of good bacteria such as lactobacilli and stimulates intestinal immunity [25].

Unlike other bacterial strains considered probiotics, such as *Lactobacilli* and *Bifidobacteria*, *Enterococcus faecium* and *Bacillus subtilis* pose specific risks that require rigorous selection to verify their efficacy and safety. Concerns have been raised about the safety of certain strains of *Enterococcus faecium* as a probiotic dietary supplement due to this microbe's tendency to develop and acquire antimicrobial resistance to many commonly used antibiotics, particularly vancomycin and ampicillin [26]. Subsequently, several studies have suggested that these bacteria do not pose a risk to human health and may be considered promising candidates for future use as probiotics and bioprotective cultures in the food and/or feed industries [27]. Therefore, it cannot be said that they are not probiotics, but rather probiotics that should be used with caution or under certain conditions.

Our survey results showed that more than half of the respondents selected one of the correct answers regarding the definition of prebiotics, while a minority of participants chose the second correct answer and a small proportion of respondents stated that they did not know the definition of prebiotics. Similarly, this study showed that fructooligosaccharides and galactooligosccharides are the most popular prebiotics (51% vs. 42.7%) chosen by respondents. In the same perspective, a survey showed that 40% of dietitians participating in this study correctly defined prebiotics, thus 63% of respondents confirmed that not all dietary fibers are prebiotics and only 10% of participants responded appropriately that psyllium is not the best-known prebiotic; which highlighted a lack of awareness of the most studied prebiotics such as galactooligosaccharides and inulin-type fructans [17]. Another study by Oliver et al. [18] in 2014 highlighted a lack of familiarity with the term prebiotic, to the extent that only 22% of healthcare professionals were familiar with the word "prebiotic" and 78% of them managed to choose the correct definition of probiotics from the choices offered, so 17% got confused and gave the definition of probiotics to prebiotics. As well as health professionals when asked about the correct sources of prebiotics they recommend inappropriate sources and general healthy food groups (fruits, vegetables, grains) instead of prebiotic compounds such as inulin or fructooligosaccharides.

Today, there is confusion about the relationship between prebiotics and dietary fiber, specifically whether all prebiotics can be considered dietary fiber and vice versa. However, the Dietary Guidelines Advisory Committee (DGAC) in 2010 notes that not all dietary fiber is prebiotic, but all prebiotics are dietary fiber [28].

To date, our study was the first to assess healthcare professionals' knowledge of the gut microbiota and its relationship to diet. The results of our study on the definition of the gut microbiota showed that 39.9% of participants selected the incorrect statement, while varying proportions – ranging from 14% to 60.8% – of participants chose one of the correct statements regarding the definition of the gut microbiota. Furthermore, a small number of healthcare professionals mistakenly believed that a Western diet and lifestyle are associated with a diverse gut microbiota, while the correct statement chosen by the majority of the sample was "The more diverse the diet, the more diverse the gut microbiota". Mitsou et al. [17] in 2024 showed that 83% of participants reported a fair to good level of knowledge about the role of nutrition and diet as modulators of the gut microbiota. For all participants and dietitians, the median knowledge score on nutrition as a modulator of the gut microbiota was 8 out of 11 questions.

The results of our survey show that a small proportion of participants identified butyrate as a short-chain fatty acid, while acetate was recognized as a short-chain fatty acid by more than half of the

respondents and a small number of participants considered the branched-chain amino acid "leucine" to be a short-chain fatty acid. Short-chain fatty acids (SCFAs) are the primary products of dietary fiber fermentation by gut microbes; these SCFAs have beneficial effects on energy metabolism and glucose homeostasis. However, the percentage of correct answers among participants regarding the role of SCFAs in glucose homeostasis remained below 50%.

According to our findings, most healthcare professionals prescribe probiotics/prebiotics to patients to restore the balance of the gut microbiome, primarily to treat antibiotic-induced diarrhea and functional bowel disorders, as well as to strengthen immunity.

According to our findings, most healthcare professionals prescribe probiotics/prebiotics to patients, with the aim of restoring the balance of the gut microbiota, primarily to treat antibiotic-induced diarrhea and functional bowel disorders, as well as to strengthen immunity. These results concur with those of Abbas et al. [29] in 2024, who showed through a survey of pharmacists that 91.2% recognized the role of prebiotics in immune support and only 30% were aware of their cardiovascular benefits. Johnson et al. [30] showed a considerable difference in the recommendation of probiotics between healthcare professionals: 51.6% of nurses recommended them, compared with 91.2% of dieticians and 78% of GPs. According to the results of a study conducted in Mexico revealed that 56.5% of gastroenterologists prescribed probiotics to treat diseases and 39% of nutritionists prescribed them for health maintenance [21]. In parallel, a study conducted in Italy showed that gastroenterologists were more scientifically sound and followed guidelines when prescribing probiotics for conditions such as irritable bowel syndrome and inflammatory bowel disease [31]. Scientific research along the same lines showed that 99.7% of pharmacists and 97.7% of doctors prescribed probiotics for digestive ailments, and only 29.3% of pharmacists recommended them for genital-urinary problems, and 15.1% of doctors recommended them for dermatological symptoms [32].

The results obtained on respondents' knowledge of prebiotics, probiotics and the microbiota highlighted that respondents had a mean total score of 40.60 reflecting a low score, with a high standard deviation (18.32). This testifies to variability between participants, as well as the fact that the score of general practitioners is homogeneous and higher compared to specialist doctors and nurses, moreover nurses had an asymmetrical distribution of scores; with a statically significant difference in total score between the different groups of professionals. In Saudi Arabia, a study revealed that gastroenterologists' knowledge levels of probiotics and prebiotics are higher than dieticians', and 83.3% of gastroenterologists believe in their benefits for people with irritable bowel syndrome versus only 50% of dieticians [33], while general practitioners and dieticians generally report less in-depth knowledge of prebiotics and symbiotics [34-35]. In the same vein, another study showed that no significant differences were observed in knowledge between doctors, pharmacists and nutritionists [23].

According to our findings, participants' sources of information are quite varied, but most healthcare professionals rely on information from websites, while academic training and specialized journals serve as sources of information for only a small proportion of participants. In the United Arab Emirates, professional training and workshops determine pharmacists' knowledge of probiotics and prebiotics [29].

Recommendations can be made to strengthen healthcare professionals' knowledge through introducing modules on gut microbiota, probiotics, and prebiotics into the basic training curriculum for healthcare professionals, developing continuing education: organizing seminars and practical workshops for healthcare professionals and facilitating access to credible scientific resources.

CONCLUSION

In conclusion, this study highlighted the current knowledge of healthcare professionals in the Kénitra city about probiotics, prebiotics and the gut microbiota. Participants have gaps in definitions, knowledge of probiotics, prebiotics and gut microbiota, as well as probiotic strains and the role of prebiotic metabolites in maintaining and preventing host health. For this reason, further research is required to clarify and project the results obtained in the different regions of Morocco.

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Conflict of interest

The authors report there are no competing interests to declare.

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