Use of probiotics in community pharmacy in South Africa: a survey of pharmacist attitudes, perceptions and knowledge

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Abstract

Background: Probiotics are live microorganisms that confer health benefits by positively influencing gut microbiota and overall gastrointestinal health. Pharmacists, as key healthcare professionals, are well-positioned to educate both patients and other practitioners on the appropriate use of probiotics. However, in South Africa, there is limited research on pharmacists' knowledge, attitudes, and perceptions regarding probiotic supplements. This study aimed to assess the knowledge, attitudes, and perceptions of community pharmacists in South Africa toward the use of probiotics through a structured survey.

Methods: A cross-sectional, descriptive survey was conducted among community pharmacists across South Africa.

Results: Of the respondents, 18.5% demonstrated a high level of knowledge about probiotics, while 11.3% showed poor knowledge (Mean ± SD = 13.81 ± 2.8). Positive attitudes were observed in 51.3% of participants, whereas 47.6% exhibited positive perceptions. Statistically significant but weak correlations were found between knowledge and attitudes (r = 0.1537, p = 0.0179), and between attitudes and perceptions (r = 0.3214, p < 0.0001).

Conclusion: The findings reveal that while pharmacists generally hold positive attitudes and perceptions toward probiotics, their knowledge remains limited. This study highlights a critical gap and underscores the need for targeted educational initiatives to enhance pharmacists' understanding and effective communication regarding probiotic use in clinical practice.

Keywords: probiotics; community pharmacy; knowledge; attitudes; perceptions

https://doi.org/10.36303/SAPJ.3129

Introduction

Following the global trend in the last decade, there was a substantial increase in the consumption of probiotics in South Africa and the demand for probiotics is expected to expand following the increased dietary supplement usage in Africa as well as the entry of major probiotic companies into the South African market.[1] The benefits of probiotics and their relevance to different populations are attracting the attention of healthcare professionals.[2,3]

Pharmacists, as experts in the field of medicine, play an important role in educating both patients and other healthcare professionals on the use of probiotics in the healthcare setting.[4] Moreover, pharmacists are entrusted with the responsibility of supplying products following evidence-based decision-making principles according to section 2.3 of Good Pharmacy Practice in South Africa.[5] There have been several international studies focused on the use of probiotics by pharmacists, and these studies concluded that it is essential for health practitioners, including pharmacists, to provide scientifically validated recommendations on the selection of probiotics.[4,6-9] However, the attitudes, perceptions and knowledge of pharmacists regarding probiotic supplements has not yet been examined in South Africa. Consequently, this study aimed to assess pharmacist perceptions, attitudes, and knowledge regarding probiotics. Additionally, it aimed to investigate the rationale behind the selection and recommendation of probiotic supplements by pharmacists, the formal education received on the use of probiotics, and the pharmacists' understanding of the associated risks and benefits related to the use of probiotics.

Methodology

Study design

A cross-sectional, descriptive study was conducted with community pharmacists across South Africa from January 2023 to September 2023.

Sample size

There are 3 845 community pharmacies registered across South Africa.[5] Each pharmacy is mandated to have a minimum of one pharmacist according to the Regulation 34 of Pharmacy Act, 1974 (Act No. 53 of 1974).[10] The sample size was equated as 350 participants, calculated using the Cochrane formula, taking into account the population size of 3 845 community pharmacies and allowing for a margin of error of 5% and a confidence level of 95%.

Data collection

This survey encompassed eight demographic questions, which included biological sex, gender, age, geographic location, and education. The remaining questions related to knowledge (comprising 16 Yes/No questions and three Multiple Choice questions), attitudes (consisting of five Likert-like questions, six Yes/No questions, and one Multiple Choice question), and perceptions (involving eight Likert-like questions). These

questions were selected from previous surveys among health-care professionals concerning the use of probiotics.[4,6] The questions were validated through institutional ethics review and peer evaluation. A pilot survey was conducted, and statistical tests were performed to evaluate the validity of the questions.

A link to the survey was distributed to community pharmacists via email using data from the South African Pharmacy Council (SAPC). The link was also shared within South African pharmacy social media groups, including Facebook and LinkedIn. Data collection was facilitated through the use of REDCap version 13.11.4. The survey was conducted with strict adherence to principles of confidentiality and anonymity. Individual identities were not collected, and the results of the study contain no personally identifiable information. Access to the data is limited solely to the researcher and supervisors.

Data analysis

Data were analysed quantitatively using descriptive statistical analysis and inferential statistics. The electronic data was analysed using statistical software (STATA SE 17.0). Numerical variables were presented as mean ± SD, and categorical variables were presented as percentages (%). The level of knowledge was categorised into three groups: good, fair, and poor; good if the respondent's total score was 75% or more, fair if 50–75%, and poor if less than 50% of the maximum score. Attitude scores were categorised as positive if the total score was greater than or equal to the mean score and negative if it was below the mean score. Perception scores were categorised as positive if the total score was greater than or equal to the mean score and negative if it was below the mean score. A Chi squared test was used to test the statistical differences among demographics and knowledge, attitudes and perceptions. Spearman's rank correlation coefficient was used to analyse the relationship between attitudes, perceptions and knowledge. In all tests, a $p < 0.05$ was considered statistically significant.

Results

Demographic characteristics of participants

Of the 476 study respondents, only 237 (49.8%) were included in the final analysis, as 239 surveys were incomplete. The respondents were from eight provinces, namely Eastern Cape, Free state, Gauteng, KwaZulu-Natal, Limpopo, Mpumalanga, North-West, and Western Cape. Most respondents (71.7%) were female. More than one third (40.9%) were between 21–30 years old and 34.2% were between 31–40 years old. The highest number of respondents (78.1%) attained education up to the Bachelor of Pharmacy degree level, with more than half (57.8%) graduating with a Bachelor of Pharmacy degree in 2021 or later. None of the respondents graduated with a Bachelor of Pharmacy degree before 1960, and only 0.8% graduated between 1960–1970. The distribution of graduates was highest from the University 1 (21.9%). A comprehensive overview of the demographic characteristics of the respondents is presented in Table I, designed with reference to the study by Arshad et al.[11]

Knowledge of probiotics

Table II depicts the knowledge levels of the respondents regarding the use of probiotics. Among the respondents, 18.5% demonstrated a good level of knowledge about probiotics, while 11.3% demonstrated a poor level of knowledge (Mean ± SD = 13.81 ± 2.8). A large percentage of the respondents were aware (88.6%) that not all bacteria cause infections. Most of the respondents (83.5%) defined probiotics correctly by recognising that probiotics contain live microorganisms (Table III), however, a small percentage answered that probiotics contain dead micro-organisms (17.7%), herbs (10.1%) and synthetic medicine (14.3%). Regarding the benefits of probiotics, 83.5% of the respondents knew that probiotics alter the intestinal microbiota and confer an immunomodulatory effect (66.2%). The majority of the respondents (70.9%) were aware that probiotics are effective as an adjuvant in *Helicobacter pylori* infection (Table III).

In terms of the potential for probiotics to carry antimicrobial resistant genes, 71.5 % were not aware of this possibility, and 73.4% of the respondents incorrectly answered that there is a benefit to probiotics being resistant to antimicrobials as indicated in Table III. When considering potential side-effects of probiotics, most respondents (67.9%) were unaware that symptoms such as bloating, constipation and diarrhoea could be side-effects of probiotics use. In terms of the respondents' knowledge of the minimum number of strains that should be contained in a probiotic supplement (Figure 1), the highest number of respondents indicated 'more than five strains' (27.4%), followed by 'two strains' (13.5%). Only 5.1% of the respondents answered 'three strains' and a small number of respondents (9.7%) answered that the number of strains that should be contained in a probiotic supplement was not important. Regarding the minimum number of Colony Forming Units (CFUs) that should be contained in a probiotic supplement (Figure 1), 33.3% of the respondents correctly stated that there should be the minimum number of billion CFUs in a probiotic supplement while 16.9% of the respondents suggested the minimum should be one million CFUs. Less than one third of the respondents (29.5%) answered that they do not know what the minimum number of CFUs in a probiotic supplement should be. Regarding their knowledge of micro-organisms that may be contained in a probiotic supplement (Figure 1), the most recognised micro-organisms were *Lactobacillus acidophilus* (70.9%), *Lactobacillus reuteri* (69.2%), *Lactobacillus rhamnosus* (57.0%), *Bifidobacterium bifidum* (45.1%), *Saccharomyces boulardii* (28,3%), *Bacillus subtilis* (15.2%), *Enterococcus faecium* (7.2%), *Escherichia coli* (3.0%), *Streptococcus pyogenes* (2.5%), *Candida albicans* (2.1%), *Staphylococcus aureus* (1.7%), and *Mycobacterium avium* (1.3%).

Attitudes towards probiotics

Attitude scores were categorised as positive if the total score was greater than or equal to the mean score and negative if it was below the mean score. Half of the respondents (51.3%) displayed positive attitudes toward probiotics as depicted in Table II (Mean ± SD = 43.33 ± 8.9). Regarding recommending probiotics to patients for various health conditions, the majority of respondents (92.4%) recommended probiotics for patients taking antibiotics (Table IV).

Table I: Relationship between demographics and knowledge, attitudes, and perceptions of pharmacists on the use of probiotics

Variables	Number of pharmacists (%)	Knowledge (%)				Attitudes			Perceptions		
		Good	Fair	Poor	X2 (*p* value)	Positive	Negative	X2 (*p* value)	Positive	Negative	X2 (*p* value)
Biological sex	237(100)				39.2132 (0.047)			95.1638 (0.024)			
Male	65(27.4)	12(18.5)	32(49.2)	21(32.3)		38(58.5)	27(41.5)		35(53.8)	30(46.2)	
Female	170(71.7)	14(8.2)	128(75.3)	28(16.5)		80(47.1)	90(52.9)		78(45.9)	92(54.1)	
Prefer not to say	2(0.8)	1(50.0)	1(50.0)	0(0.0)		1(50.0)	1(50.0)		0(0.0)	2(100.0)	
Age	237(100%)				92.4945 (0.125)						110.9219 (0.712)
21–30 years old	97(40.9)	13(13.4)	66(68.0)	18(18.6)		51(52.6)	46(47.4)		53(54.6)	44(45.4)	
31–40 years old	81(34.2)	14(17.3)	60(74.1)	7(8.6)		37(45.7)	44(54.3)		37(45.7)	44(54.3)	
41–50 years old	17(7.2)	3(17.6)	13(76.5)	1(5,9)		10(58.8)	7(41.2)		8(47.1)	9(52.9)	
51–60 years old	24(10.1)	10(41.7)	14(58.3)	0(0.0)		13(54.2)	11(45.8)		6(25.0)	18(75.0)	
61–70 years old	12(5.1)	4(33.3)	8(66.7)	0(0.0)		7(58.3)	5(41.7)		8(66.7)	4(33.3)	
71–80 years old	5(2.1)	3(60.0)	1(20.0)	1(20.0)		1(20.0)	4(80.0)		1(20.0)	4(80.0)	
Prefer not to answer	1(0.4)	0(0.0)	1(100.0)	0(0.0)		0(0.0)	1(100.0)		0(0.0)	1(100.0)	
Highest degree obtained	237(100%)				51.4647 (0.495)			191.4276 (0.003)			64.6228 (0.894)
Bachelor's degree	185(78.1)	20(10.8)	144(77.8)	21(11.4)		94(50.8)	91(49.2)		85(45.9)	100(54.1)	
Master's degree	37(13.6)	11(29.7)	23(62.2)	3(8.1)		17(45.9)	20(54.1)		18(48.6)	19(51.4)	
Doctorate	1(0.4)	0(0.0)	1(100.0)	0(0.0)		0(0.0)	1(100.0)		0(0.0)	1(100.0)	
Other	8(3.4)	3(37.5)	3(37.5)	2(25.0)		3(37.5)	5(62.5)		5(62.5)	3(37.5)	
Prefer not to say	6(2.5)	0(0.0)	5(83.3)	1(16.7)		2(33.3)	4(66.7)		5(83.3)	1(16.7)	
Year graduated Bachelor of Pharmacy	237(100%)				103.2375 (0.179)						115.9658 (0.932)
1961–1970	2(0.8)	0(0.0)	1(50.0)	1(50.0)		1(50.0)	1(50.0)		1(50.0)	1(50.0)	
1971–1980	9(3.8)	1(11.1)	8(88.9)	0(0.0)		5(55.6)	4(44.4)		4(44.4)	5(55.6)	
1981–1990	21(8.9)	12(57.1)	9(42.8)	0(0.0)		13(61.9)	9(38.1)		10(47.6)	11(52.4)	
1991–2000	23(9.7)	3(13.0)	19(82.6)	1(4.4)		12(52.2)	11(47.8)		8(34.8)	15(65.2)	
2001–2010	20(8.4)	3(15.0)	16(80.0)	1(5.0)		6(30.0)	14(70.0)		6(30.0)	14(70.0)	
2011–2020	137(57.8)	22(16.1)	93(67.9)	22(16.0)		64(46.7)	73(53.3)		70(51.1)	67(48.9)	
2021 or later	16(6.8)	3(18.8)	12(75.0)	1(6.2)		11(68.8)	5(31.2)		9(56.3)	7(43.7)	
Prefer not to answer	9(3.8)	1(11.1)	7(77.8)	1(11.1)		7(77.8)	2(22.2)		5(55.6)	4(44.4)	
University graduated	237(100%)				139.0936 (0.277)			417.7753 (0.007)			238.5135(0.032)
University 1	52(21.9)	9(17.3)	39(75.0)	4(7.7)		30(57.7)	22(42.3)		22(42.3)	30(57.7)	
University 2	26(11.0)	5(19.2)	19(73.1)	2(7.7)		10(38.5)	16(61.5)		9(34.6)	17(65.4)	
University 3	22(9.3)	3(13.6)	15(68.2)	4(18.2)		11(50.0)	11(50.0)		9(40.9)	13(59.1)	
University 4	16(6.8)	5(31.2)	9(56.3)	2(12.5)		9(56.3)	7(43.7)		5(31.3)	11(68.7)	
University 5	14(5.9)	3(21.4)	8(57.2)	3(21.4)		6(42.9)	8(57.1)		5(35.7)	9(64.3)	
University 6	49(20.7)	13(26.5)	33(67.4)	3(6.1)		26(53.1)	23(46.9)		30(61.2)	19(38.8)	
University 7	20(8.4)	1(5.0)	15(75.0)	4(20.0)		7(35.0)	13(65.0)		12(60.0)	8(40.0)	
University 8	5(2.1)	0(0.0)	4(80.0)	1(20.0)		2(40.0)	3(60.0)		2(40.0)	3(60.0)	
University 9	9(3.8)	1(11.1)	7(77.8)	1(11.1)		3(33.3)	6(66.7)		7(77.8)	2(22.2)	
Other	14(5.9)	3(21.4)	9(64.3)	2(14.3)		5(35.7)	9(64.3)		5(35.7)	9(64.3)	
Prefer not to say	10(4.2)	1(10.0)	8(80.0)	1(10.0)		8(80.0)	2(20.0)		7(70.0)	3(30.0)	

Table II: Pharmacists' knowledge, attitudes, and perceptions score

Knowledge (%)			Attitudes (%)			Perceptions (%)		
Fair	Good	Mean ± SD	Negative	Positive	Mean ± SD	Negative	Positive	Mean ± SD
70.2	18.5	13.81 ± 2.8	49.7	51.3	43.33 ± 8.9	52.4	47.6	32.14 ± 3.7

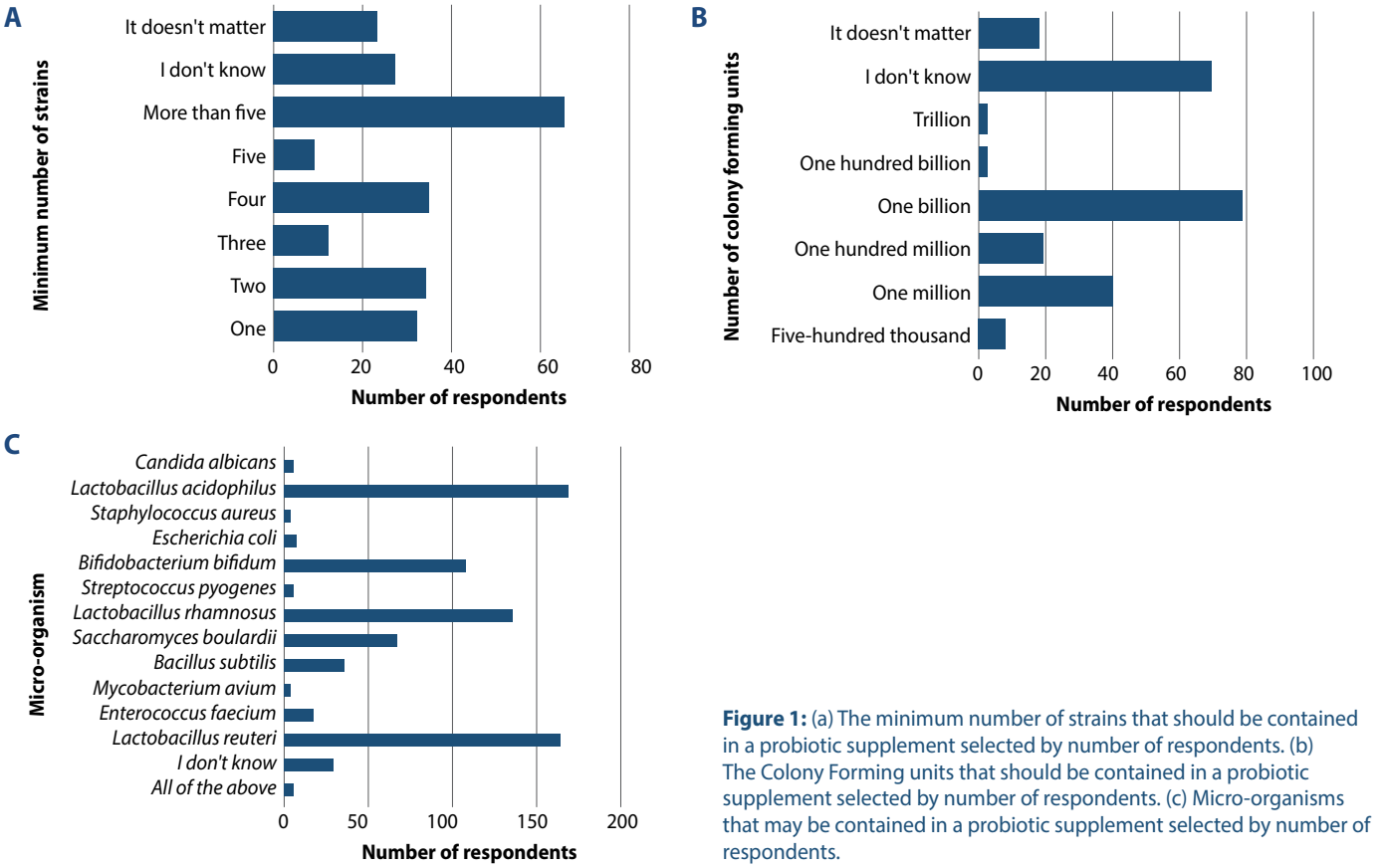

Figure 1: (a) The minimum number of strains that should be contained in a probiotic supplement selected by number of respondents. (b) The Colony Forming units that should be contained in a probiotic supplement selected by number of respondents. (c) Micro-organisms that may be contained in a probiotic supplement selected by number of respondents.

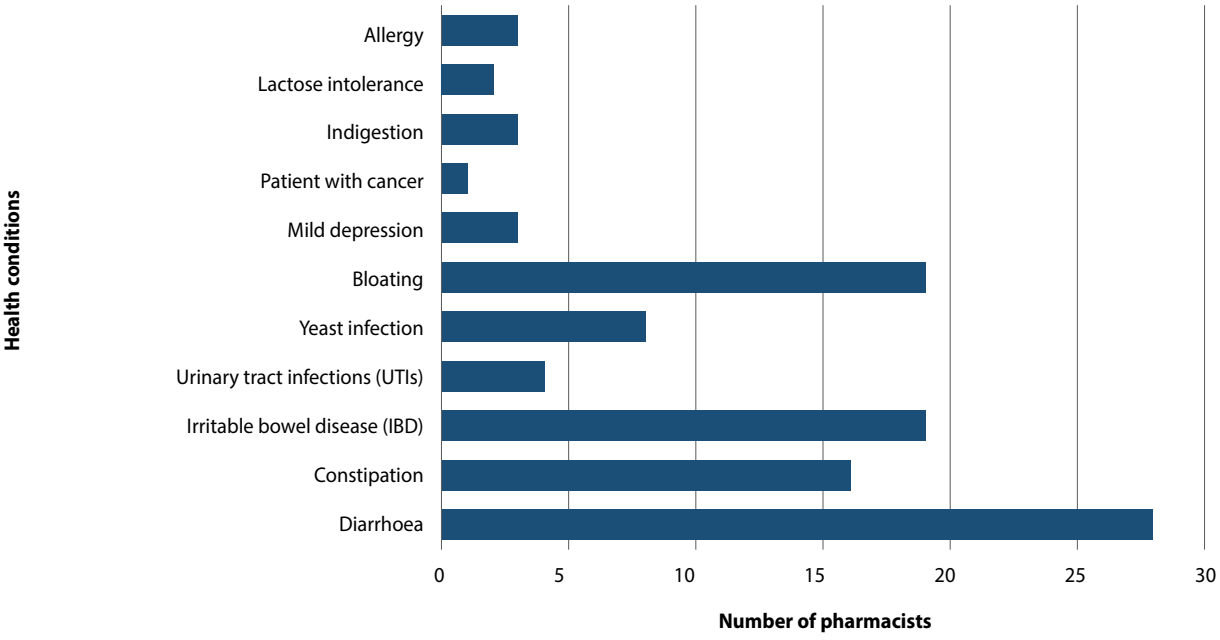

Figure 2: A summary of health conditions beyond those listed in the questionnaire for which respondents recommend the use of probiotics.

Table III: Knowledge of respondents on the use of probiotics

Questions	Correct answer *n* (%)	Incorrect answer *n* (%)	I don't know *n* (%)
Probiotics contain live micro-organisms.	198(83.5)	27(11.4)	12(5.1)
Probiotics contain dead micro-organisms.	167(70.5)	42(17.7)	28(11.8)
Probiotics contain synthetic medicine.	179(75.5)	34(14.3)	28(11.8)
Probiotics contain herbs.	191(80.6)	24(10.1)	22(9.3)
Probiotics alter the intestinal microbiota.	198(83.5)	38(16.1)	1(0.4)
Probiotics confer an immunomodulatory effect.	157(66.2%)	51(21.5)	29(12.2)
Protics are effective as an adjuvant in *Helicobacter pylori* infection eradications.	168(70.9)	27(11.4)	42(17.7)
Probiotics assist with antibiotic side-effects.	226(95.4)	9(3.8)	2(0.8)
Probiotics can carry antimicrobial resistant genes.	70(29.5)	120(50.6)	47(19.8)
There is a benefit to probiotics being antimicrobial resistant.	63(26.6)	92(38.8)	82(34.6)

Table IV: Attitudes and perceptions of respondents towards the use of probiotics

Questions	Positive *n* (%)	Negative *n* (%)	Neutral *n* (%)
Attitudes			
I recommend probiotics to patients taking antibiotics.	219(92.4)	12(5.1)	6(2.5)
I recommend probiotics to patients being treated for *H. pylori*.	124(52.4)	34(14.3)	79(33.3)
I recommend probiotics to patients for general health conditions.	167(70.5)	34(14.4)	36(15.2)
I provide advice on probiotics to patients.	210(84.8)	16(6.8)	20(8.4)
I recommend probiotics to patients for side-effects of antibiotics.	208(87.8)	16(6.8)	13(5.5)
I have looked up to see how many strains of bacteria are contained in the probiotic dispensed.	149(62.9)	86(36.3)	2(0.8)
I have looked up to see the number of Colony Forming Units contained in the probiotic dispensed.	103(43.5)	130(54.9)	4(1.7)
I have looked up to see which micro-organisms may have antibiotic resistance.	50(21.1)	179(75.5)	8(3.4)
Perceptions			
Probiotics may be beneficial to patients.	92(92.4)	6(2.6)	12(5.1)
Probiotics may be harmful to patients.	29(12.2)	139(58.7)	69(29.1)
There is sufficient evidence regarding efficacy of probiotics.	137(57.8)	36(15.2)	64(27)
Health claims on probiotic labels can be trusted.	78(33.0)	67(28.3)	92(38.8)
There are appropriate guidelines on the use of probiotics in South Africa.	63(26.6)	95(40.1)	79(33.3)
It is the responsibility of a pharmacist to know about probiotics.	110(90.7)	5(2.1)	17(7.2)
I have an adequate knowledge on the use of probiotics.	55(43.4)	73(30.8)	61(25.7)
I would like to gain more information on probiotics.	220(92.8)	8(3.4)	9(3.8)

Additionally, more than half of the respondents (52.3%) recommended probiotics to patients being treated for *H. pylori*, while 70.5% recommended probiotics for general health conditions. Figure 2 lists health conditions for which respondents recommend probiotics beyond those specified in the survey. Notably, respondents highlighted the recommendation of probiotics for addressing diarrhoea (28 respondents), while some respondents advocated their use for both Irritable Bowel Disease and bloating (19 respondents). Additionally, respondents recommended probiotics for addressing constipation (16 respondents). This study indicated that 84.8% of the respondents provided advice on probiotics to patients. Majority of the respondents showed interest in confirming specific aspects of the probiotics they dispensed, with 62.9% verifying to see how many strains of bacteria are contained in the probiotic dispensed, 43.5% verifying the number of CFUs contained in the probiotic dispensed, and 75.5% verifying to see if micro-organisms may have antibiotic resistance (Table IV). The highest number of respondents (67.9%) indicated that they selected a probiotic supplement based on what was on the prescription, followed by guidelines on the use of probiotics (36.7%), what was recommended by representatives (30.0%), colleagues (14.8%), articles (13.5%), internet (6.8%), and textbooks (6.8%). Other respondents explained that they used their personal experience, cost effectiveness, availability of stock, conferences, and lectures to select a probiotic supplements for patients.

Perceptions of probiotics

Perception scores were categorised as positive if the total score was greater than or equal to the mean score and negative if it was below the mean score. Less than half of the respondents (47.6%) displayed positive perceptions of probiotics as depicted in Table II (Mean ± SD = 32.14 ± 3.7). The highest number of respondents (92.4%) answered that probiotics were beneficial to patients,

and a small proportion of the respondents (12.2%) answered that probiotics may be harmful to patients (Table IV). More than half of the respondents (57.8%) agreed that there is sufficient evidence regarding efficacy of probiotics. However, there were less than half of the respondents (40.1%) who agreed that there were no appropriate guidelines on the use of probiotics in South Africa (Table IV). Less than half of the respondents (43.4%) agreed that they had adequate knowledge on the use of probiotics, and the majority of the respondents (90.7%) affirmed that it is the responsibility of a pharmacist to know about probiotics.

Relationship between demographics and knowledge, attitudes, and perceptions

Table I demonstrates the relationship between the demographics of the respondents and their knowledge, attitudes, and perceptions regarding the use of probiotics. There was a significant association of knowledge of probiotics with biological sexes ($X^2 = 39.2132$, $p < 0.05$). Female respondents had higher knowledge score (13.87 ± 2.6) than male respondents (13.68 ± 3.1).

There was a statistically significant difference in the demographics of respondents and their attitudes towards probiotics, including biological sex ($X^2 = 95.164$, $p < 0.05$), age ($X^2 = 248.008$, $p < 0.05$), highest degree obtained ($X^2 = 191.428$, $p < 0.05$), and the university from which they graduated ($X^2 = 417.775$, $p < 0.05$). Male respondents had a mean attitude score of 45.08 ± 8.4, while female respondents had a mean score of 42.68 ± 9.0. Respondents aged between 61 and 70 demonstrated the most positive attitudes towards probiotics, with a mean attitude score of 47.92 ± 7.9, with 58.3% expressing positive attitudes towards probiotics. University 1 had a mean attitude score of 44.50 ± 8.2, and 57.7% showing positive attitudes towards probiotics. University 6 had a mean attitude score of 44.47 ± 9.9 and University 4 had a mean attitude score of 43.75 ± 7.3.

There was a statistically significant difference in the demographics of respondents and their perceptions of probiotics, including age ($X^2 = 52.378$, $p < 0.05$), and the university of graduation ($X^2 = 238.514$, $p < 0.05$). Respondents aged between 61 and 70 showed the most positive perceptions towards probiotics, with a mean attitude score of 34.08 ± 3.2, and 66.7% expressing positive attitudes towards probiotics. Respondents from University 9 demonstrated had a mean attitude score of 33.78 ± 2.2, and 77.8% showing positive perceptions towards probiotics. University 6 had a mean attitude score of 33.04 ± 2.8 and University 3 had a mean attitude score of 32.50 ± 3.9.

Relationship between knowledge, attitudes, and perceptions

There was a statistically significant but weak correlation between the knowledge-attitudes variables (r = 0.1537, $p = 0.0179$) and attitude-perceptions variables (r = 0.3214, $p = 0.0000$). There was no statistically significant correlation between knowledge-perceptions variables (r = 0.0092, $p = 0.8879$). Table V displays the relationship between attitudes, perceptions, and knowledge of the respondents regarding the use of probiotics.

Table V: Relationship between knowledge, attitudes, and perceptions

Variables	Correlation Coefficient	*p*-Value
Knowledge-Attitudes	0.1537	0.018
Knowledge-Perceptions	0.0092	0.888
Attitudes-Perceptions	0.3214	0.000

Discussion

The present study aimed to investigate the knowledge, attitudes, and perceptions of community pharmacists in South Africa regarding the use of probiotics. It investigated the relationship between demographic factors of the respondents and their knowledge, attitudes, and perceptions on this subject.

The findings from the respondents revealed that a significant portion of the respondents (70.2%) had a fair level of knowledge about probiotics, with only 13.5% demonstrating a good level of knowledge. A cross-sectional study in Pakistan revealed that 25.1% of pharmacists demonstrated a good level of knowledge about probiotics,[11] while another study in India showed that 69.4% of the pharmacists had good knowledge.[7] Additionally, other studies conducted in Iran and the United States of America (USA) reported that pharmacists had higher levels of familiarity with probiotics among healthcare professionals.[12,13] The observed findings may be attributed to several factors, including the larger size of the probiotics markets in the USA and Asia.[7,14] In regions like the USA and Asia, there may be a higher level of familiarity with probiotics due to widespread marketing, higher availability of probiotic products, and a cultural emphasis on wellness and dietary supplements.[7,15] It is important to note that the limited availability of information on probiotics in South Africa could contribute to the lower level of knowledge among respondents.[14] Addressing these factors could be important in enhancing education and awareness of probiotics among pharmacists in South Africa. This can be achieved through the development of national guidelines or recommendations on probiotics, complemented by targeted awareness strategies such as professional workshops and continuing education programmes. The differences in the level of knowledge about probiotics among pharmacists in this and previous studies may also be attributed to variations in the sample population, such as differences in demographic characteristics, professional experience, practice setting, and the number and complexity of questions, which may determine the depth of knowledge required to answer.[4,7,11,16,17]

Most respondents (95.4%) correctly recognised that probiotics help alleviate side-effects of antibiotics. Additionally, 70.9% acknowledged that probiotics are effective as an adjuvant in managing *Helicobacter pylori* infections. The use of probiotics in preventing antibiotic-associated diarrhoea has been shown to reduce the risk associated with antibiotic-induced diarrhoea.[18]

Only 38.4% of the respondents answered correctly that it is necessary to consume probiotics for a long period to exert a beneficial effect. This finding contrasts with the results of an international survey on health professionals' knowledge of

probiotics, which included pharmacists and other healthcare professionals, which reported that the majority of respondents (71.5%) agreed that probiotics should be consumed for a long period of time to exert a beneficial health effect.[8] Determining the optimal duration for probiotic consumption to attain beneficial effects for specific health conditions can be challenging, mainly due to the limited evidence in studies regarding the recommended timeframe for taking probiotics.[19-21] There are studies that suggest an optimal duration for probiotic consumption to achieve beneficial effects. For example, a randomised clinical trial demonstrated that the daily intake of 10 billion CFUs of multi-strain probiotics, including *B. bifidum* W23, *B. lactis* W51, and *L. acidophilus* W37, significantly reduced overall risk of diarrhoea in children during the consumption of antibiotics and one week after the completion of the course.[22] A systematic review suggested that the treatment of acute gastroenteritis in children with *L. acidophilus* was effective when administered at a daily dosage of 10 billion CFUs daily, showing statistically significant improvement after three days of probiotic intake.[23] While no definitive duration for probiotic consumption has been established, previous studies suggest varying consumption periods.[19-21] This variability emphasises the need to establish more precise recommendations on how to use probiotics.

Regarding the knowledge of micro-organisms that might be contained in a probiotic supplement, respondents most commonly recognised the *Lactobacillus* and *Bifidobacterium* strains. This may likely be because these strains are widely known and most commonly used as probiotics.[24,25] Most respondents (70.9%) selected *L. acidophilus*, and this finding aligns with an international study where a significant proportion of respondents (92.0%) identified *L. acidophilus* as a potential micro-organism in a probiotic supplement.[8] The majority of the respondents (69.2%) selected *L. reuteri* in this study. Additionally, in this study, 71.5 % did not know that probiotics can carry antimicrobial resistant genes, and 73.4% of the respondents answered that there was a benefit to probiotics being resistant to antimicrobials. These respondents explained that one of the benefits of probiotic resistance to antibiotics is that probiotics remain unaffected by the antibiotic activity in the gut, ensuring the effectiveness of probiotics when taken concurrently with antibiotics. However, ingestion of antibiotic resistance genes could influence the pharmacodynamics of antibiotics.[26] Antibiotic resistance, in most cases, is inherent to specific species or genera and is not typically transferable, posing minimal safety concerns.[26,27] However, it is essential to carefully consider safety implications related to antibiotic resistance, especially in the context of plasmid-mediated resistance, which has the potential to transfer antibiotic resistance traits.[27] *Lactobacillus reuteri* SD 2112 (ATCC 55730) has been identified as carrying transferrable antibiotic resistance to antibiotics, including clindamycin, cefotaxime, fusidic acid, penicillin, streptomycin, tetracycline, and vancomycin.[28-30] It must be noted that *L. reuteri* was not included among the probiotic strains investigated in similar studies on the use of probiotics.[6,7,11] This may be attributed to the fact that these studies did not study the aspect of antibiotic resistance in *L. reuteri*.[6,7,11] Additionally, a small percentage of respondents (7.2%) selected *Enterococcus faecium*. Some respondents in a study conducted in Slovenia also recognised *Enterococcus faecium* as a micro-organism that might be contained in a probiotic supplement.[8] *Enterococcus faecium* has been found to exhibit resistance to various antibiotics, including tetracyclines, ciprofloxacin, and vancomycin, which raises concerns about its suitability as a probiotic strain.[31,32] Another group of respondents (3.0%) selected *Escherichia coli* as a potential probiotic strain, despite the fact that certain strains of *E. coli* are known to produce resistance to β-lactam antibiotics.[33,34] These findings emphasise the importance of accurate knowledge regarding probiotic strains and their potential interactions with antibiotics. It is only after a probiotic strain has been identified, screened, and its mechanisms of action scientifically elucidated, that it can be accurately labelled.[35]

In terms of the respondents' knowledge of the minimum number of strains that should be contained in a probiotic supplement, only 5.1% of the respondents answered 'three strains.' Studies show that probiotics with multiple strains, including at least three different strains, may provide maximal efficacy.[36-38] Additionally, a significant portion of respondents (33.3%) believed that there should be a minimum number of 10^9 CFUs in a probiotic supplement. Studies recommend a daily intake of at least 10^9 CFUs for optimal efficacy.[39-41] These findings highlight a potential gap in knowledge among the respondents regarding the minimum requirements of probiotic supplements. Specifically, 36.3% of the respondents reported not checking the number of bacterial strains in the probiotic dispensed, and 54.9% did not verify the CFUs in the probiotic dispensed. This emphasises the importance of targeted education and awareness programmes to address these knowledge gaps. Studies on the use of probiotics also stated that the implementation of educational interventions, potentially delivered over an extended period, could improve knowledge and awareness of healthcare professionals on probiotics.[4,6,8] Respondents (90.7%) agreed that it is the responsibility of a pharmacist to know about probiotics, indicating a strong interest among respondents in gaining more information about probiotics, with 92.8% expressing their desire for additional knowledge. Furthermore, 84.4% of the participants expressed a willingness to engage in training programmes or educational initiatives focused on the use of probiotics. While the intended sample size could have led to more generalisable results, the respondents' willingness to learn and participate in training suggests a potential for targeted educational interventions to enhance understanding and awareness among pharmacists.

Concerning respondents' perceptions on the safety of probiotics, 15.2% of the respondents disagreed that there is sufficient evidence regarding the efficacy of probiotics, and 28.3% expressed that health claims on probiotic labels cannot be trusted. These results also align with the analysis of probiotic and prebiotic-containing foods and supplements manufactured in South Africa.[14] The analysis has revealed that these products often

mislead consumers with scientifically inaccurate health claims.[14] Additionally, the analysis indicated that the information regarding the number of bacterial strains on product labels was frequently incorrect.[14] Therefore, it is important for pharmacists to have direct access to scientific information provided by probiotic companies. Pharmacists can use the SAHPRA website where scientific data and educational publications are readily available. Moreover, as a means of ensuring product quality and transparency, product labels should prominently feature the complete name of the probiotic strain and ensure the minimum live count of these strains throughout the product's shelf-life.

A significant but weak correlation between knowledge and attitude was identified ($r = 0.1537$, $p = 0.0179$). This indicates that respondents who had a higher level of knowledge also had a more positive attitude towards probiotics, although the correlation was weak. This finding aligns with previous studies that also showed weak correlations between knowledge and attitude on probiotics.[6,17] However, it must be noted that the previous studies encompassed a broader spectrum of healthcare professionals and students, including not only pharmacists but also physicians, nurses, and other health practitioners, as well as students from various fields of health care.

The correlation between attitudes and perception was also significant but weak ($r = 0.3214$, $p = 0.000$). This suggests that respondents with a more positive attitude also had a more positive perception towards probiotics, although the correlation was weak. There is no statistically significant correlation between knowledge-perceptions variables ($r = 0.0092$, $p = 0.8879$). This suggests that respondents with a higher level of knowledge did not necessarily have positive perceptions. These findings emphasise the complexity of factors influencing individuals' knowledge, attitudes and perceptions regarding probiotics.

Conclusion

The current study has identified predominantly limited knowledge regarding the use of probiotics among respondents, despite their positive attitudes and perceptions towards the use of probiotics. To bridge the gap between knowledge and positive attitudes and perceptions, targeted training programmes focused on probiotic use should be initiated, given that the market for probiotic consumption is growing rapidly. The study has emphasised the complexity of factors influencing individuals' knowledge, attitudes, and perceptions regarding probiotics. Pharmacists' interest in probiotics should be acknowledged for the future and current pharmacists is imperative to prevent inappropriate use of these agents.

Acknowledgements

The author acknowledges the statistician, Zvifadzo Matsena Zingoni, for her assistance in designing the statistical aspects of the study.

Conflict of interests

The authors declare that they have no financial or personal relationships that could have improperly influenced them in the writing of this article.

Funding source

This research received Faculty Research Committee funding from the Faculty of Health Sciences of the University of Witwatersrand.

Institutional Review Board Statement

Ethical clearance was achieved (M220810) by the University of the Witwatersrand Human Research Ethics Committee (medical).

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