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RESEARCH ARTICLE **OPEN ACCESS**

Public Knowledge of Human Microbiota and Its Impact on Health Behaviors: Insights Supporting SDG 3 (Good Health and Well-being)

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Abstract:

Introduction: The human microbiota plays a crucial role in maintaining health and preventing disease. Public knowledge of microbiota and its connection to health behaviors remains limited, especially in non-clinical populations. This study explores how awareness of microbiota correlates with lifestyle choices in a sample of adults.This study aimed to evaluate public knowledge of the human microbiota and examine its influence on lifestyle-related health behaviors.

Methods: A cross-sectional study was conducted through an online survey distributed *via* social media platforms. The questionnaire consisted of three sections: demographic data, microbial knowledge, and behavioral practices related to microbial health. A total of 250 valid responses were analyzed using descriptive statistics and chi-square tests.

Results: The majority of participants demonstrated basic to advanced knowledge of microbiota. Educational level and source of information were significantly associated with awareness. Participants with higher microbial knowledge were more likely to report healthy behaviors, such as prudent antibiotic use and awareness of the impact of diet and physical activity on gut health.

Discussion: The results highlight the need to raise public awareness about microbiota and its role in promoting healthy behaviors. This supports efforts aligned with SDG 3.

Conclusion: Enhancing public understanding of the microbiota is essential for promoting health-conscious behaviors. The findings support the need for targeted education campaigns and inclusion of microbiome topics in public health communication strategies.

Keywords: Microbes, antibiotics, microorganisms, public health, health behavior, SDG 3: Good Health and Well-being.

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1. INTRODUCTION

The human body hosts a vast number of micro-organisms, including bacteria, viruses, archaea, and fungi, across different anatomical regions such as the skin, gut, and mucosal surfaces. While some microbes are pathogenic, many play beneficial roles in maintaining health by supporting digestion, modulating immunity, and protecting against infection [1-3]. The human microbiota is now recognized as a key factor influencing various physiological and metabolic processes [1, 4]. Research

indicates that daily lifestyle factors, including diet and physical activity, can shape the composition and function of the microbiota [4-6].

Disruptions in microbial communities—often termed 'dysbiosis'—have been associated with gastrointestinal diseases, dermatological conditions, and even cancer [7-9]. Understanding these relationships is crucial to promoting healthier lifestyles. Public knowledge of microbiota is still emerging, and increasing awareness could influence behaviors such as antibiotic use, diet, and physical activity [10-12].

While previous studies have explored public knowledge of the microbiota or the role of fecal microbial transplantation [13, 14], few have investigated the direct link between microbial knowledge and behavioral choices in non-clinical populations. This study aims to evaluate public knowledge of human microbiota and examine how that knowledge correlates with health-related behaviors, particularly lifestyle choices and antibiotic use.

Bactericidal disorders are linked to many illnesses, such as infections in the bowel [7], skin [8], and tumors [9]. Understanding the role of microbes in the body by learning how to make a healthy lifestyle, such as eating healthy food [10], engaging in physical activity [6], or taking antibiotics wisely [11]. Other studies have agreed to evaluate awareness of health issues, such as antibiotic use or preventive measures against infectious diseases, which suggests that knowledge about a particular issue is often reflected in behaviors and attitudes [12, 15]. Knowledge of microbes in the public, including an understanding of microbiota, is expected to influence decisions on a social level as well, and can direct decision-makers [16].

Previous studies have mainly focused on the knowledge of microbiota [13] and the cultivation of fecal microbiota [14].

This sectional meta-study aimed to measure knowledge subject to microbes, first, learning about microbes and how the microbiota impacts antibiotics, and second, evaluating lifestyle choices affected by knowledge of microbes.

2. METHODS

2.1. Study Design and Participants

This cross-sectional study was conducted through an online questionnaire distributed *via* social media platforms (Twitter, WhatsApp, and Telegram). The inclusion criteria required participants to be adults aged 18 years or older residing in Saudi Arabia. There were no exclusion criteria beyond age and informed consent.

2.2. Questionnaire Development

The survey was administered in Arabic and designed based on prior validated instruments. The questionnaire underwent pilot testing in earlier studies to assess clarity and reliability [13, 14]. It consisted of 32 items categorized into three sections: (1) demographic information (sex, age, education level, specialty, preferred knowledge source); (2) knowledge of microbes and microbiota; and (3) attitudes and behaviors related to microbial health.

Knowledge questions used a five-point scale: 'I have no idea', 'sure not', 'maybe not', 'maybe', and 'sure'. Responses of 'maybe' and 'sure' were grouped as 'agree', while 'sure not' and 'maybe not' were categorized as 'disagree'; 'maybe' was also analyzed separately as 'uncertain'. Correct responses were scored as 1, and incorrect responses as 0.

Behavioral beliefs were assessed with a four-point Likert scale: 'definitely not', 'probably not', 'probably', and 'definitely'. The responses 'probably' and 'definitely' were categorized as 'agree', and 'definitely not' and 'probably not' as 'disagree'.

2.3. Ethical Considerations

The study was reviewed and approved by the Ethics Committee of Qassim University, Saudi Arabia (Approval No. 23-089-E). All participants provided informed consent prior to participation. This study adhered to the principles of the Declaration of Helsinki.

2.4. Data Analysis

All data were analyzed using SPSS version 27. Descriptive statistics were used to summarize participant characteristics. Chi-square tests were performed to examine associations between knowledge level and behavioral responses. Significance was set at $p < 0.05$.

2.5. Study Design

An online survey was distributed using Google Forms. The link to the questionnaire was shared *via* popular social media platforms.

2.6. Participants Designing

The survey included an explanation of its purpose, content, and participant confidentiality. The survey was conducted in Arabic. The questionnaire was piloted in prior studies to assess its validity and reliability, which consisted of 32 statements divided into three parts: (1) personal information about them, (2) learning about bacterial microbes, and (3) behavioral beliefs' impact on microbes.

The demographic section included items on sex, age, education level, specialization, and preferred sources of microbiota knowledge. Participants self-reported their microbiota knowledge as Poor (no prior learning), Basic (general awareness), or Advanced (formal education in microbiology). Participants also examined whether they wanted to know more about the microbes and which resources they preferred.

The knowledge part consists of five answers to 15 questions: “I have no idea, sure not, maybe not, maybe, sure.” Answers such as 'maybe' and 'sure' were categorized as agreement. “Sure not, and maybe not” are pointed to as “I do not agree,” however, “maybe” is pointed to as “uncertain.” Data were estimated to learn about the microbes. To record microbial learning, the true

and incorrect answers were recorded as 1 and 0, respectively.

The attitude section included 10 statements rated using a 4-point Likert scale: “definitely not, probably not, probably, and definitely.” The answers “probably and definitely” are referred to as “agree” in the results section, and the answers “definitely not and probably not” are referred to as “disagree”. Additionally, lifestyle choices have an impact on microbial learning.

2.7. Statistical analysis

The collected data were statistically analyzed using SPSS (Statistical Descriptive Analysis of Frequencies and Chi-Square).

3. RESULTS

3.1. Participant Characteristics

A total of 250 participants completed the survey. Of these, 42.4% were male and 57.6% were female. Educational attainment varied: 24% had a high school education or less, 10.8% held a diploma, 56.8% held a bachelor's degree, and 8.4% had postgraduate degrees. Knowledge of microbiota was self-rated as poor (29.6%), basic (56%), or advanced (14.4%).

3.2. General Knowledge of Microbiota

Most participants agreed that most bacteria do not cause disease (64.8%) and that bacterial cells outnumber human cells in the body (46%). Misconceptions were noted: 28.8% believed that bacteria on the skin always cause disease, and 24.8% held the same belief for gut bacteria. Only 36.4% correctly rejected the presence of bacteria in the brain. A majority (64%) agreed that physical activity influences microbial health, and 40% recognized that microbial composition varies by geography and ethnicity.

3.3. Knowledge of Microbes and Antibiotics

About 36.4% believed that antibiotics selectively kill harmful bacteria, while 57.2% agreed that antibiotics could eliminate beneficial bacteria. Moreover, 56% acknowledged that antibiotic use could lead to health issues by disrupting beneficial microbes. Awareness of probiotic restoration post-antibiotic use was moderate (56%).

3.4. Knowledge Level and Antibiotic Attitudes

Participants with advanced knowledge were significantly less likely to believe that antibiotics kill only harmful bacteria (12.1%), compared to those with basic (62.6%) or poor (25.3%) knowledge ($p < 0.001$). Similarly, those with advanced knowledge were more aware of antibiotic risks and microbial restoration.

3.5. Impact of Knowledge on Lifestyle Beliefs

Participants with higher microbiota knowledge were more likely to agree that such knowledge influenced their dietary decisions and attitudes toward antibiotic use ($p = 0.027$). However, there was no significant difference regarding the belief that good bacteria influence lifestyle choices in general ($p > 0.05$).

3.6. Willingness to Learn

Interest in learning more about the microbiota was high across all knowledge levels. Preferred sources included social media, healthcare professionals, and reliable medical websites, with preferences varying by education level.

3.7. Demographics and General Characteristics of Participants

A total of 250 participants completed the survey. Among them, 42.4% identified as male, and 57.6% as female (Table **1**). Participants’ educational levels were categorized as follows: 24% high school or less, 10.8% diploma, 56.8% bachelor’s degree, and 8.4% postgraduate degree. (Table **2**). Regarding the knowledge level of microbes (explained in the second section), Knowledge levels were reported as 14.4% advanced, 56% basic, and 29.6% poor. (Table **3**).

Table 1. Demographics and general characteristics of participants (Sex).

	Frequency	
Valid	Male	166
	Female	144
	Total	250

Table 2. Study level (SL)

Frequencies		Percentage	Correct Percentage	Accumulative Percentage
General secondary or less	60	24.0	24.0	24.0
Diploma	27	10.8	10.8	34.8
Bachelor's	142	56.8	56.8	91.6
Post-graduate studies	21	8.4	8.4	100.0
Total	250	100.0	100.0	

Table 3. Knowledge level of microbes.

Frequency		Percent	Correct Percentage	Accumulative Percentage
Poor	74	29.6	29.6	29.6
Basic	140	56	56	85.6
Advanced	36	14.4	14.4	100
Total	250	100	100	

3.8. General Knowledge of Microbiota

We evaluated participants' beliefs about the role of bacteria in causing diseases. To this end, agreement was measured using the phrases “most bacteria do not cause disease” and “the number of bacterial cells exceeds the number of human cells in our bodies.” Most respondents agreed with the statements, with 64.8% and 46% respectively. (Table **4**). This is evidence that the majority of them learn that bacteria do not always cause an illness. It is believed that in various parts of the body, bacteria always cause illness, and 28.8% of bacteria in the skin always cause illness. The same outcome was observed for the bacteria in the digestive system (Table **4**). The addition of bacteria to the brain, unlike the digestive system or surface, is not a place for microbes. The correct percentage was that bacteria in the brain were linked to illness (36.4%) (Table **4**).

The majority were unaware that healthy food may contain beneficial bacteria. (Table **4**).

The majority (64%) believed that physical activities affect microbes, suggesting awareness of the relationship between behavior and microbial health.. Furthermore, (40%) the vast majority believed that bacteria varied from country to country and from race to race.

3.9. Learning the Link between Microbes and Antibiotics

The assessment was assessed (data 9–12 in Table **4**). Most of them agreed that antibiotics had an impact on microbes. In contrast, 36.4% of the respondents believed that only harmful bacteria were killed (Table 4). 8.8% of respondents disagreed about the ability of bacterial treatment, and 35.2% were unsure (Table **4**), reflecting a high level of uncertainty.

3.10. Degrees of Learning

Knowledge gaps linked to antibiotic use and their effects on microorganisms were identified by analyzing responses related to the effect of antibiotics on these organisms within various sets (Table **5**). Higher learning showed a higher level of awareness about the impact of antibiotics on microbes, with 34 out of 36 agreeing, 93 out of 140 agreeing with basic knowledge, and 27 out of 74 agreeing that they could harm good bacteria. Out of 31 people with advanced knowledge, out of 36 compared to 88 out of 140 people with basic knowledge, and 24 out of 74 people with poor knowledge believed that the use of antibiotics may lead to diseases by killing beneficial bacteria. On the other hand, only 12.1% of advanced knowledge agreed with the statement “antibiotics kill only harmful bacteria,” while 62.6% of basic knowledge and 25.3% of poor knowledge agreed ($p<0.001$) on the same statement (Table **5**).

3.11. Impact on Lifestyle

To assess whether microbiota learning could influence behavioral beliefs, microbiota knowledge does not match the impact behavior, nor do various groups with the statement ” knowledge the good bacterial affects lifestyle choices” (31 out of 36, 123 out of 140, and 69 out of 74, respectively, agreed with the p-value = 1.874). In addition, advanced, basic, and poor knowledge were not observed to differ on the statement “knowledge on the good microbes affect the taking of antibiotics” (33 out of 36, 127 out of 140, and 71 out of 74, respectively, agreeing with the value of p = 1.919) (Table **6**). However, the impact of microorganisms on food (34 out of 36, 133 out of 140, and 70 out of 74, respectively, agreed with a p-value = 0.027) (Table **6**).

3.12. Willingness to Learn about Microbiota

At the end of the survey, participants were asked to identify their preferred source of information about the microbiota, with four options available: social media, healthcare, news sources, and reliability. The results showed that they must desire to acquire knowledge of microbes (Table **7**).

4. DISCUSSION

This study evaluated public knowledge of the human microbiota and its association with health-related behaviors in a sample of Saudi adults. Overall, the results demonstrate moderate awareness of the microbiota, with variations in knowledge translating into differences in antibiotic use, dietary habits, and willingness to learn.

Findings align with previous literature indicating that individuals with higher knowledge of microbes are more likely to engage in health-conscious behaviors, including cautious use of antibiotics and dietary choices supportive of gut health [11, 12, 17]. However, a substantial portion of participants still held misconceptions, such as the belief that all bacteria on the skin or in the digestive tract cause disease, highlighting a need for targeted education.

Advanced knowledge of microbiota correlated significantly with accurate beliefs about antibiotics, including awareness of their effect on beneficial bacteria and the concept of microbial restoration. This suggests that microbiota literacy may influence responsible antibiotic practices, which is particularly relevant in light of growing global concerns about antimicrobial resistance [18, 11].

Table 4. Knowledge of microbiota among participants.

Statement	Agree	Uncertain	Disagree
1. Most bacteria do not cause disease	162	59	29
	64.8%	23.6%	11.6%
2. The number of bacterial cells exceeds the number of human cells in our bodies	115	91	44
	46%	36.4%	17.6%
3. Bacteria on skin always causes diseases	72	75	103
	28.8%	30%	41.2%
4. Bacteria on digestive system always causes diseases	62	75	113
	24.8%	30%	45.2%
5. Presence of bacteria on brain always causes diseases	91	90	69
	36.4%	36%	27.6%
6. Exercise can positively affect the beneficial bacteria	160	75	15
	64%	30%	6%
7. Bacteria vary between countries and races	100	76	74
	40%	30.4%	29.6%
8. Healthy foods should not contain any type of bacteria	91	76	83
	36.4%	30.4%	33.2%
9. Antibiotics only kill harmful bacteria	91	78	81
	36.4%	31.2%	32.4%
10. Antibiotics only kill beneficial bacteria	154	75	21
	61.6%	30%	8.4%
11. Antibiotics can cause diseases by killing beneficial bacteria	143	85	22
	57.2%	34%	8.8%
12. Bacteria can be given orally to replace beneficial bacteria that are killed after antibiotic treatment	140	88	22
	56%	35.2%	8.8%

Table 5. Relationship between antibiotics and microbiota.

		Advanced (N=36)		Basic (N=140)		Poor (N=74)		*p*-value
Statement		Counting	Percent	Counting	Percent	Counting	Percent	
Antibiotics only kill harmful	Agree	11	12.1%	57	62.6%	23	25.3%	0.001>
Can kill beneficial		34	22.1%	93	60.4%	27	17.5%	0.001>
Can cause diseases by killing beneficial bacteria		31	21.7%	88	61.5%	24	16.8%	0.001>
Can replace beneficial killed		29	20.7%	86	61.4%	25	17.9%	0.001>

Table 6. Effect on behavioral beliefs.

		Advanced (N=36)		Basic (N=140)		Poor (N=74)		*P*-value
		Counting	Percent	Counting	Percent	Counting	Percent	
I can take pills	Agree	33	14.4%	129	56.3%	67	29.3%	0.162
Knowing bacteria affects lifestyle choices		31	13.9%	123	55.2%	69	30.9%	1.874
Diet is influenced by knowledge of bacteria		34	14.4%	133	56.1%	70	29.5%	0.027
Knowing on beneficial bacteria affects my use of antibiotics		31	14.3%	127	55%	71	30.%	1.919

Table 7. Willingness to learn about microbes.

			Count	Percentage
I would be interested in learning more about the microbiota	Yes	Advanced	35/36	14.6%
		Basic	136/140	56.9%
		Poor	68/74	28.5%
	No	Advanced	1/36	9.1%
		Basic	4/140	36.4%
		Poor	6/74	54.5%
If your answer is yes, what is your preferred method for doing so?	Social media	Advanced	11/36	9.4%
		Basic	66/140	55.9%
		Poor	41/74	34.7%
	Health care	Advanced	1/36	7.1%
		Basic	10/140	71.4%
		Poor	3/74	21.5%
	News sources	Advanced	2/36	66.7%
		Basic	0/140	0%
		Poor	1/74	33.3%
	Reliable medical sources	Advanced	22/36	20.6%
		Basic	61/140	57%
		Poor	24/74	22.4%

Despite generally positive attitudes, the lack of clear differences in some behavioral beliefs—such as whether knowledge of microbes influences lifestyle broadly—may reflect conceptual confusion or superficial understanding among those with basic or poor knowledge. This indicates a gap between factual knowledge and its practical application in everyday health decisions.

The high interest in learning more about microbiota, especially through accessible platforms like social media and healthcare professionals, supports the potential for effective public health interventions. Efforts to integrate microbiota-related content into educational campaigns could foster informed behavior and enhance public engagement with health topics.

Compared to earlier studies, this research contributes by linking microbiota knowledge directly to behavioral dimensions, not merely descriptive knowledge levels. Nonetheless, the cross-sectional design limits causal interpretation, and reliance on self-reported data may introduce recall and social desirability biases.

Awareness of how the human microbiota affects health is crucial at both individual and community levels, as awareness impacts individuals' lifestyles and choices, and helps guide policymakers in shaping their media and policy decisions [14].

Participants' interpretation of absolute terms such as 'always' may have influenced their responses. Despite this, the survey was successful in assessing microbial knowledge, with participants who classified themselves as having advanced knowledge showing significantly higher cognitive scores than those with basic or poor knowledge.

The survey indicated that most participants were aware that the presence of bacteria on the skin or in the digestive system was not always associated with the disease. In addition, most agree that the presence of bacteria in the human body could have a positive effect. Several behavioral and environmental elements influence the composition of the microbiota, such as physical activity, sweating, and geographic site, demonstrating their understanding of microbiome diversity among individuals and the impact of behavioral elements on it. This learning is thought to be the result of one-sided individual choice and did not consistently recognize how microbial knowledge could shape lifestyle decisions. Understanding the impact of different behaviors on the functioning of biobiotic bacteria can be an important point for health care to create good lifestyles, such as activities and diet [10].

People with basic or poor learning of microbiology showed an unexpectedly good level of knowledge of microbiota. This acquired knowledge can be explained through various sources, such as formal education in schools or universities, social media, or popular science aimed at the general public [14].

An important part of understanding the microbiota is the effect of antibiotics on microorganisms, especially given the diseases together with the long-term use of antibiotics and the increase in antibiotic resistance in pathogenic microbes globally, which is part of the misuse of antibiotics [17].

Emerging technologies such as machine learning have shown promise in predicting host-pathogen interactions and could play a role in personalized microbial health strategies [19].

CONCLUSION

This study highlights the importance of microbiota awareness in shaping health behaviors related to antibiotic use and lifestyle choices. Although many participants demonstrated basic to moderate understanding, misconceptions and gaps remain. Improving public microbiota literacy may support better

antibiotic stewardship, healthier dietary decisions, and greater engagement in preventive health behaviors. Public health efforts should consider integrating microbiota-related content into community education, particularly through accessible and trusted channels. Future research is needed to evaluate whether enhanced microbiota knowledge translates into measurable changes in behavior over time.

The human microbiota plays an essential role in maintaining health and well-being. An understanding of the microbiota is constantly evolving, and our awareness of the importance of knowledge of the human microbiota is increasing. Recent studies emphasize the importance of microbes in various physiological processes. Educational campaigns can be conducted on the human microbiota and introduced into school curricula. It is also preferable to enhance the scientific content on social media regarding human microbes and their impact on our lives. Further research is necessary to identify gaps in microbiota awareness and to determine whether filling these gaps can promote healthy behavior.

STUDY LIMITATIONS

This study has several limitations. First, the cross-sectional design prevents assessment of causality between microbiota knowledge and behavior. Second, data collection relied on self-reported information, which may be influenced by recall bias and social desirability bias. Third, the use of online survey distribution may have excluded individuals without internet access, potentially affecting representativeness.

AUTHORS' CONTRIBUTIONS

The authors confirm their contribution to the paper as follows: AA collected and analyzed the data. NAS conceptualized the study, supervised the methodology, and prepared the final manuscript. Both authors reviewed and approved the final version of the manuscript.

ETHICAL APPROVAL AND CONSENT TO PARTICIPATE

The study was approved by the ethics committee of qassim university, Saudi Arabia (Approval no. 23-089-E).

HUMAN AND ANIMAL RIGHTS

No animals were used in this research. All procedures performed in studies involving human participants were in accordance with the ethical standards of institutional and/or research committee and with the 1975 Declaration of Helsinki, as revised in 2013.

CONSENT FOR PUBLICATION

All participants provided informed consent prior to participation

STANDARDS OF REPORTING

The study followed the STROBE (Strengthening the Reporting of Observational Studies in Epidemiology) guidelines.

AVAILABILITY OF DATA AND MATERIAL

The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

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CONFLICT OF INTEREST

The author(s) declare no conflict of interest, financial or otherwise.

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