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Parental Digital Health Literacy and Appropriate Antibiotic-Seeking Behaviour for Childhood Illness in Bangladesh: The Mediating Role of Knowledge of Antimicrobial Resistance

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ABSTRACT

This research aims to understand the relationship between parental digital health literacy and adequate antibiotic seeking behaviour for childhood diseases in Bangladesh, focusing on the knowledge of antimicrobial resistance and confidence in seeking professional advice. A cross-sectional survey 560 complete observations. Appropriate antibiotic seeking behaviour, digital health literacy and confidence in seeking professional advice were modelled as reflective constructs and antimicrobial resistance knowledge was operationalised as a seven-item factual scale. 2,000 bootstrap samples were used to apply partial least squares structural equation modelling. The measurement model showed good test–retest reliability and presented good criterion-related and content-related validity. Digital health literacy was a positive predictor of antimicrobial resistance knowledge, confidence in seeking professionals' advice and appropriate antibiotic seeking behaviour. There were positive associations between the levels of antimicrobial resistance knowledge and professional-advice confidence and antimicrobial resistance appropriate behaviour. Appropriate antibiotic seeking behaviour was most directly associated with confidence in seeking professional advice. The indirect effect via antimicrobial resistance knowledge was significant, demonstrating mediation. The model accounted for 35.8% of the variance in appropriate antibiotic seeking behaviour. The results suggest that enhancing parents' skills in assessing digital health information could help them make safer choices about antibiotic use alongside increased knowledge about the facts of resistance and trust in seeking advice from trained healthcare providers during standard childhood infections.

INTRODUCTION

The extent to which antibiotics are effective has become a significant challenge in the management of infectious disease, as this is not only dependent on the clinical prescribing process, but also on the ways drugs are accessed, retrieved, and utilized within families. When children become ill, decisions made by parents/caregivers are especially significant. The signs and symptoms like fever, cough, respiratory discomfort, diarrhea and weakness frequently engender an urgent demand for reassurance and treatment (Noor *et al.*, 2023). During these times, caregivers might turn to qualified health professionals, pharmacies for advice, relatives, the Internet or home remedies. Such pathways may influence the appropriate acquisition of antibiotics, or the inappropriate use of antibiotics.

The modern information landscape is another layer to this issue. Parents are now faced with information about health issues via search engines, social media, messaging apps, websites, and online communities. Digital access can make individuals more aware and enable their caregivers to determine when professional help is needed. But having access to information does not necessarily imply that the information can be assessed appropriately. The information found online is widely inconsistent in terms of reliability, clinical relevance and clarity (Dantuluri *et al.*, 2023). There may be too much information available for a caregiver to learn and discern which sources they can rely on, how to compare contradictory information, or whether general information is applicable to a specific child. Digital health literacy is thus a functional ability to find, evaluate, understand, and apply online health-related information in ways that enable proper health care seeking (Hicks *et al.*, 2021).

Knowledge about antimicrobial resistance is also a critical factor in antibiotic decision-making. One of the responsibilities for caregivers is to identify a bacterial illness from an illness in which antibiotics are not likely to be effective. They should also be made aware that misuse, using a leftover medication, or not following the usage directions given by the medical professional can lead to misuse of antibiotics and increase resistance. But changing people's knowledge is not enough to ensure they behave correctly. Parents might have some understanding of antibiotic resistance, but also seek antibiotics informally when they are hard to get, when family members urge them to take antibiotics, or when they do not trust communication with a health care worker (Romandini *et al.*, 2021).

So, confidence in seeking professional advice is relevant to the behavioural pathway. Those parents who feel they can describe the symptoms, ask questions about the need for

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an antibiotic, seek clarification, and refuse to get medicines without being consulted may be better equipped to turn information into safer action. Digital health literacy may help bolster this confidence with credible information online equals preparation for consultation (Hassan *et al.*, 2021). It could also be accompanied by information on antimicrobial resistance, providing parents with a more solid foundation on which to discuss treatment decisions. The context of Bangladesh is relevant to the study of such linkages. The strong expansion of Internet access in the country is accompanied by persistent differences in health care accessibility, affordability, health literacy, and medicine-seeking actions. Caring for individuals often involves an overload of information and, at the same time, limitations to access formal consultation. It is important, hence, to understand how digital capabilities, factual knowledge, and confidence intertwine so that interventions can be designed that go beyond simple awareness campaigns (Rahman *et al.*, 2021).

This study examines the functional nexus of parent's eHealth literacy and safe antibiotic seeking practice for children's illnesses in Bangladesh. It focuses specifically on knowledge of antimicrobial resistance as the mediator and confidence in seeking professional advice as an additional pathway. The study discriminates between capability to assess AMR online health content, factual knowledge of AMR, confidence in consulting the information and reported behaviour. This separation is not only conceptually important, but also these domains are related and not interchangeable.

The study contributes by testing the structured PLS-SEM model with data from 560 parents or primary carers. It investigates if there is any association between AMR knowledge, confidence in seeking professional advice and appropriate antibiotic-seeking behaviour with digital health literacy. It further examines the relationship of AMR knowledge with consultation confidence & behaviour, the relationship of confidence with behavior, and the mediation of the relationship between digital literacy and behaviour. The study combines informational, cognitive, and behavioural components to offer a more fine-grained description of the potential pathways between parent exposure to digital information and safer antibiotic use decision making for children.

LITERATURE REVIEW

Parental Digital Health Literacy

Digital health literacy is the functional skill to find, comprehend, evaluate and use health-related information encountered online. This competence is more advanced than just using the internet when it comes to the field of childhood diseases. Parents are responsible for assessing who created the information, the credibility of the source, evaluating the feedback provided from various sources and understanding the limitations of generic online information (Samir *et al.*, 2021). They also need to figure out a time when digital information is enough to take care of themselves, and when it's time for a professional evaluation. These skills are particularly applicable to antibiotic decisions, as much of the conversation online remains a combination of the different natures of symptoms, diagnoses, medicine names and personal experiences and non-professional recommendations (Kabir *et al.*, 2023).

Improving digital health literacy can foster more conscious choices about health care. If the parent can recognize reliable information, he or she might be less inclined to accept unsupported statements that antibiotics are necessary for common viral illnesses (Bert *et al.*, 2022). Digital literacy can also foster opportunities for preparing for clinical experiences. Credible information can be utilized by parents to develop questions, clarify concerns and develop a better understanding of professional explanations. Digital health literacy will thus be positively related to factual antimicrobial resistance knowledge and confidence in seeking professional advice (Akhtar *et al.*, 2021).

Knowledge of Antimicrobial Resistance

The knowledge of the antimicrobial resistance is factual knowledge and not perceived confidence or agreement. It contains the element of recognition that antibiotics are not for the treatment of viral infections, that the overuse can be part of a problem, that bacteria may become less susceptible to antibiotics and that antibiotics that are leftover or not used correctly may be inappropriate (Parveen *et al.*, 2020). The importance of measuring this domain as a factual knowledge is that agreement scales can inflate understanding when people agree to a statement because it is socially desirable, not because they know it is scientifically correct (Alima *et al.*, 2023).

Knowledge can affect behaviour, by enhancing the reasoning behind considering treatment options. Parents who have some understanding of why an antibiotic is not always appropriate might be more accepting of a clinician's decision not to prescribe an antibiotic (Aika & Enato, 2023). They also might not be as likely to use remaining medication or demand a particular antibiotic without evaluation. Factively aware and knowledgeable caregivers, on the other hand, might enhance consultation confidence, as they have a better vocabulary for questions and advice. The framework therefore posits that AMR knowledge will correlate positively with a disposition to seek professional advice, and with antibiotic-seeking behaviour (Applegate *et al.*, 2020).

Confidence in Seeking Professional Advice

The dimensions for confidence in seeking professional advice include perceived competence in identifying the need for professional advice, describing child's symptoms, asking for antibiotic, asking for clarification, and preference for professional assessment in the face of informal pressure (Akter *et al.*, 2023). This is a different construct than access to health care. A caregiver might be a neighbor to a provider but not feel comfortable asking questions, but another might have access issues but feel

comfortable talking with a clinician (Nafei *et al.*, 2022). Consultation confidence can act as a behaviourally bridging link between information and action. Digital health literacy can support them in getting ready to engage with health care providers, and AMR knowledge can contribute to antibiotic-focused discussions (Ahmed *et al.*, 2020). If signs can be explained and their usefulness of antibiotics questioned, caregivers may be less inclined to get an antibiotic based on family advice or media/social media or from prescribed use. Therefore, having confidence in seeking professional advice is predicted to be positively associated with appropriate antibiotic-seeking behaviour (Shah *et al.*, 2022).

Appropriate Antibiotic-Seeking Behaviour

Appropriate antibiotic seeking behaviour is when a caregiver states they would do when deciding if an antibiotic was needed for their child's sickness. The construct highlights professional evaluation and not necessarily the use of an antibiotic in the end (Paul *et al.*, 2022). Appropriate behaviours are to seek advice from a qualified health care professional, describe their symptoms and refrain from requesting a specific medication, accept the judgment of a health care professional regarding the use of an antibiotic, avoid using a leftover antibiotic or a prescription for another person (Van Hecke *et al.*, 2022). This behavioural emphasis is crucial as antibiotic stewardship at household level is not synonymous with abstaining from antibiotic use in all situations. For some infections, it may be clinically appropriate to use an antibiotic (Unicomb *et al.*, 2021). The question is whether there are qualified assessments and proper communication in the decision. This is because a behaviour-based measure doesn't assume all receipts of antibiotics are used incorrectly and hence offers a more defensible result when looking at parental decision-making processes (Salam *et al.*, 2023).

Conceptual Framework and Hypotheses

The conceptual framework has placed parental digital health literacy as the main upstream capability. Digital literacy is posited to encourage factual knowledge and confidence in seeking professional advice on AMR; and to keep an immediate link between digital literacy and antibiotic-seeking behaviour (Shamim *et al.*, 2023). AMR knowledge is identified as the mediator between the DHL and behaviour. Enhancing confidence in consultation and direct association to appropriate behaviour are also proposed. The confidence pathway to behaviour includes trust in professional expertise.

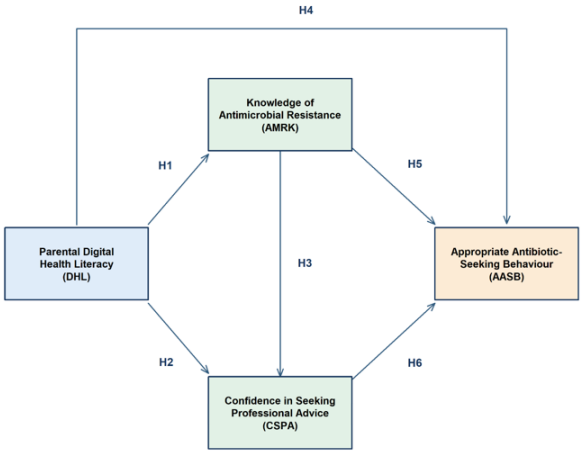


Figure 1: Conceptual framework and hypothesised structural relationships.

The framework thus examines seven hypotheses. H1 is parental digital health literacy is positively related to AMR knowledge. H2 suggests that there is a positive relationship between digital health literacy and confidence in asking for professional advice. H3 assumes that there is a positive relationship between AMR knowledge and professional-advice confidence. H4 suggests that digital health literacy is positively related to proper antibiotic-seeking behaviour. H5 suggests that appropriate behaviour is positively related to AMR knowledge. H6 Appropriate behaviour is positively related to confidence in seeking professional advice. Based on this, H7 suggests that the positive link between parental digital health literacy and appropriate antibiotic-seeking behaviour is mediated by AMR knowledge. These paths in conjunction separate access and assessment of digital information from factual knowledge and interpersonal self-confidence and self-reported information-seeking behaviours (Bosley *et al.*, 2022).

The mediating proposition represents a serial information process. Digital literacy could enhance the quality of the information that parents assess, behaviour could improve when the credible information turns into accurate AMR knowledge. A substantial indirect effect would reflect a partial pathway between being digitally literate and a behavioural outcome via factual knowledge in addition to other pathways within families.

MATERIALS AND MEHTHODS

Study Design and Participants

A quantitative cross sectional survey design was implemented to assess the relationships between

parental digital health literacy, awareness of antimicrobial resistance, confidence to seek professional advice and antibiotic seeking behaviors (Earley, 2023). 560 respondents were included in the analytic data, and 560 cases had complete data on the variables included in the structural equation model. Respondents had to be ≥18 years of age, parents or primary carers of children < 12 years resident in BD and use a smartphone and/or the internet to get information about a child's health in the last 12 months and take care of a child who had an illness for which treatment was considered in the last 6 months. For those children where multiple children were cared, the results for behaviour were based on the last recent qualifying illness.

Survey Instrument and Measures

The questionnaire included screening questions, caregiver and household characteristics, three multi-item constructs, a factual AMR knowledge test, and additional questions regarding receipt and recommendation of antibiotics. Seven items were used to assess parental digital health literacy, including information search, checking sources, assessing credibility, comparing source credibility, understanding how information might be limited in certain contexts, and using reliable information to prepare for the professional consultation. Responses were on a 5-point scale from very difficult to very easy (Moura & Neves, 2025).

Five items were used to assess confidence when seeking professional advice. This measured self-perceived ability to identify need for professional assessment, to communicate symptoms, to inquire about the need for antibiotic, to ask professional for clarification, and to seek professional advice against pressure from family members. Appropriate antibiotic-seeking behaviour was assessed with 5 items that related to the last qualifying childhood illness. Items included professional consultation, communication based on symptoms, accept professional assessment, avoidance of an antibiotic because of informal advice, and omitting use of antibiotic leftover or previously prescribed. For both constructs, there were five-point response scales.

To evaluate AMR knowledge, seven factual statements were made using a true/falseness and an "I don't know" option. One point was awarded for every correct answer; a zero point for those who answered incorrect or "I don't know." The items were added up to create an observed score on the AMRK from zero to seven. This variable did not have reflective latent constructs.

Descriptive Analysis

Model assessment was preceded by descriptive analysis. Caregiver relationship, age, education, residence, administrative division, child age, internet health-information use, consultation affordability, and travel time to a qualified health care professional were summarised using frequencies and percentages. Receiving antibiotics, source of antibiotics recommendation, and explanation of antibiotic prescription instructions were analysed separately as they were supplementary descriptors and not AASB indicators. For the three reflective scales, item means and standard deviations were presented, and for each AMR knowledge item, percentages correct were presented. Descriptive statistics (distribution, mean, standard deviation and median) of the summed AMRK score were used. Since there were 560 observations in the data set and complete-case analysis was used, no imputation was needed for structural analysis.

PLS-SEM Procedure

Partial least squares structural equation modelling was adopted in an analysis that involved multiple reflective constructs, a single factual knowledge score and that had direct and indirect relationships tested. Digital health literacy, antibiotic seeking behaviour and confidence seeking professional advice were estimated as reflective constructs. AMRK was added to the model as an observed composite score.

Structural paths were interpreted after measuring the measurement model. Reliability of the items was assessed by their indicator loadings. Cronbach's alpha and composite reliability were adopted to assess the internal consistency. Average variance extracted (AVE) was used to evaluate convergent validity, in which a value > 0.50 means that a construct accounted for over half of the variance of the indicators. Heterotrait-monotrait (HTMT) was used to assess the discriminant validity between the three reflective constructs. Inner variance inflation factors were checked for potential problematic collinearity of predictors.

R-squared and adjusted R-squared values for endogenous variables and f-squared statistics for effect sizes of the predictors were calculated for the structural model assessment. Standardised path estimates for the six direct hypotheses were employed. Bootstrap standard errors, t-values, p-values and 95% confidence intervals were reported and statistical inference was based on 2,000 bootstrap samples. The mediation hypothesis was assessed using the bootstrapped indirect effect of digital health literacy on the appropriate antibiotic-seeking behaviour through AMR knowledge. Indirect effects, to explain the broader mechanism shown in the model, were also estimated for exploratory purposes. Due to the cross-sectional nature of the study, statistically significant paths were interpreted as only associations according to the proposed framework and not evidence of temporal or causal relationships.

RESULTS AND DISCUSSION

Respondent Profile and Descriptive Findings

As for the respondent profiles, mothers (66.6%) made up the largest group followed by fathers (29.1%). The age group of the respondents was mostly 25-34 years (51.6%) and Secondary or Higher secondary education was prevalent. Of the sample 57.0% were in rural households. Dhaka's share of the division was the highest

Table 1: Respondent and household characteristics

Variable	Category	Frequency	Valid_N	Percent_of_Valid
Relationship to child	Mother	373	560	66.6
Relationship to child	Father	163	560	29.1
Relationship to child	Other primary caregiver	24	560	4.3
Relationship to child	Missing	0	560	
Caregiver age	18–24 years	59	560	10.5
Caregiver age	25–34 years	289	560	51.6
Caregiver age	35–44 years	165	560	29.5
Caregiver age	45 years or older	47	560	8.4
Caregiver age	Missing	0	560	
Education	No formal education	34	560	6.1
Education	Primary	77	560	13.8
Education	Secondary	168	560	30
Education	Higher secondary	150	560	26.8
Education	Undergraduate	95	560	17
Education	Postgraduate or higher	36	560	6.4
Education	Missing	0	560	
Residence	Rural	319	560	57
Residence	Urban	241	560	43
Residence	Missing	0	560	
Administrative division	Barishal	44	560	7.9
Administrative division	Chattogram	106	560	18.9
Administrative division	Dhaka	133	560	23.8
Administrative division	Khulna	61	560	10.9
Administrative division	Mymensingh	36	560	6.4
Administrative division	Rajshahi	71	560	12.7
Administrative division	Rangpur	55	560	9.8
Administrative division	Sylhet	54	560	9.6
Administrative division	Missing	0	560	
Child age at illness	Under 1 year	46	560	8.2
Child age at illness	1–4 years	265	560	47.3
Child age at illness	5–8 years	179	560	32
Child age at illness	9–11 years	70	560	12.5
Child age at illness	Missing	0	560	
Internet health-information use	Less than monthly	15	560	2.7
Internet health-information use	Monthly	127	560	22.7
Internet health-information use	Weekly	262	560	46.8
Internet health-information use	Several times a week	128	560	22.9
Internet health-information use	Daily	28	560	5
Internet health-information use	Missing	0	560	
Difficulty paying for consultation	Never	132	560	23.6
Difficulty paying for consultation	Rarely	145	560	25.9
Difficulty paying for consultation	Sometimes	135	560	24.1
Difficulty paying for consultation	Often	96	560	17.1

Difficulty paying for consultation	Always	52	560	9.3
Difficulty paying for consultation	Missing	0	560	
Travel time to healthcare professional	Under 15 minutes	78	560	13.9
Travel time to healthcare professional	15–30 minutes	141	560	25.2
Travel time to healthcare professional	31–60 minutes	174	560	31.1
Travel time to healthcare professional	More than 60 minutes	99	560	17.7
Travel time to healthcare professional	Unsure	68	560	12.1
Travel time to healthcare professional	Missing	0	560	

at 23.8%. Almost half of the index children were under five years. The most prevalent weekly pattern of Internet use for child-health information was every week (46.8%). Financial and geographic barriers were also evident with 26.4% indicating that they often or always had problems paying for consultation and 48.8% requiring more than half an hour to access a qualified healthcare professional.

Table 2: Antibiotic use and recommendation

Variable	Category	Frequency	Valid_N	Percent_of_Valid
Antibiotic given	Yes	188	560	33.6
Antibiotic given	No	372	560	66.4
Antibiotic given	Unsure	0	560	0
Antibiotic given	Missing	0	560	
Who recommended the antibiotic	Qualified healthcare professional	149	560	26.6
Who recommended the antibiotic	Pharmacy worker without consultation	20	560	3.6
Who recommended the antibiotic	Family member or friend	7	560	1.2
Who recommended the antibiotic	Parent/caregiver	11	560	2
Who recommended the antibiotic	Other	1	560	0.2
Who recommended the antibiotic	Not applicable	372	560	66.4
Who recommended the antibiotic	Missing	0	560	
Clarification of instructions	Yes	81	560	14.5
Clarification of instructions	No	16	560	2.9
Clarification of instructions	Nothing was unclear	52	560	9.3
Clarification of instructions	Not applicable	411	560	73.4
Clarification of instructions	Missing	0	560	

66.4% said no antibiotic was administered during this particular illness, 33.6% reported that an antibiotic had been administered. For the entire sample, 26.6% of the respondents said that a qualified healthcare provider was the one to recommend the antibiotic, while fewer said they received recommendations from family or friends, a pharmacist, or themselves. Fourteen and a half percent of the respondents indicated that instructions for antibiotics were clarified and 9.3% indicated that they were not unclear. The high proportion of not-applicable is due to an antibiotic not being used or clarification not being applicable for a large number of persons (Kabir *et al.*, 2023).

Table 3: Questionnaire item descriptive statistics

Construct	Item	Valid_N	Mean	SD	Percent_Correct
DHL	DHL1	560	3.02	0.94	
DHL	DHL2	560	3.05	0.93	
DHL	DHL3	560	3.08	0.95	
DHL	DHL4	560	3.04	0.92	
DHL	DHL5	560	3.03	0.96	
DHL	DHL6	560	3.04	0.95	
DHL	DHL7	560	3.01	0.94	

CSPA	CSPA1	560	3.12	1.03	
CSPA	CSPA2	560	3.15	1.03	
CSPA	CSPA3	560	3.11	1.02	
CSPA	CSPA4	560	3.09	1.01	
CSPA	CSPA5	560	3.13	1.06	
AASB	AASB1	560	3.01	1.04	
AASB	AASB2	560	3.08	1.06	
AASB	AASB3	560	3	1.07	
AASB	AASB4	560	3.07	1.02	
AASB	AASB5	560	2.99	1.05	
AMRK	AMRK1	560			51.79
AMRK	AMRK2	560			48.21
AMRK	AMRK3	560			47.14
AMRK	AMRK4	560			53.93
AMRK	AMRK5	560			58.04
AMRK	AMRK6	560			57.14
AMRK	AMRK7	560			49.11

Means for items on the three reflective scales were near the middle of the five-point response scales. DHL item means ranged from 3.01 to 3.08, CSPA means from 3.09 to 3.15, and AASB means from 2.99 to 3.08. The average levels are in the moderate range and there is no evidence of a strong ceiling effect. Factual knowledge about AMR was mixed. The proportion of correct responses varied from 47.14% (AMRK3) to 58.04% (AMRK5) with significantly room for improvement across each of the seven knowledge areas.

Table 4: AMR knowledge score distribution

AMRK_Score	Frequency	Percent_of_Valid	Mean	SD	Median
0	10	1.79			
1	49	8.75			
2	92	16.43			
3	105	18.75			
4	119	21.25			
5	108	19.29			
6	57	10.18			
7	20	3.57			
Overall	560	100	3.65	1.65	4

The mean of the summed AMR knowledge score was 3.65 out of 7, the standard deviation was 1.65, and the median was 4. The scores of 3, 4, and 5 were most common and contributed 59.29% of the respondents. Only 3.57% gave all seven items a correct answer. On the other hand, 10.54% got 0 or 1. From this distribution, we hypothesize that the antimicrobial resistance factual knowledge among the participating caregivers is moderate but incomplete.

Measurement Model Assessment

The reflective indicators are highly loaded on their respective constructs. DHL loadings ranged from 0.832 to 0.862, CSPA loadings from 0.844 to 0.879, and AASB loadings from 0.836 to 0.860. Cronbach's alpha varied between 0.903 and 0.935 and composite reliability ranged between 0.928 and 0.947. High internal consistency of these results without any weak indicator to discard on loading grounds.

Table 5: Outer loadings and internal consistency

Construct	Indicator	Outer_Loading	Cronbach_Alpha	Composite_Reliability
DHL	DHL1	0.852	0.935	0.947
DHL	DHL2	0.832	0.935	0.947
DHL	DHL3	0.859	0.935	0.947
DHL	DHL4	0.842	0.935	0.947
DHL	DHL5	0.862	0.935	0.947

DHL	DHL6	0.846	0.935	0.947
DHL	DHL7	0.838	0.935	0.947
CSPA	CSPA1	0.856	0.914	0.936
CSPA	CSPA2	0.844	0.914	0.936
CSPA	CSPA3	0.876	0.914	0.936
CSPA	CSPA4	0.859	0.914	0.936
CSPA	CSPA5	0.879	0.914	0.936
AASB	AASB1	0.84	0.903	0.928
AASB	AASB2	0.854	0.903	0.928
AASB	AASB3	0.86	0.903	0.928
AASB	AASB4	0.836	0.903	0.928
AASB	AASB5	0.851	0.903	0.928

The reflective indicators are highly loaded on their respective constructs. DHL loadings ranged from 0.832 to 0.862, CSPA loadings from 0.844 to 0.879, and AASB loadings from 0.836 to 0.860. Cronbach's alpha varied between 0.903 and 0.935 and composite reliability ranged between 0.928 and 0.947. High internal consistency of these results without any weak indicator to discard on loading grounds.

Table 6: Convergent validity

Construct	Cronbach_Alpha	Composite_Reliability	AVE	AVE_Above_0_50
DHL	0.935	0.947	0.718	Yes
CSPA	0.914	0.936	0.745	Yes
AASB	0.903	0.928	0.72	Yes

The three reflective constructs had acceptable convergent validity. AVE was 0.718 for DHL, 0.745 for CSPA, and 0.720 for AASB, with every value exceeding 0.50. Internal consistency indices were satisfactory. The indicators' variance was thus accounted for significantly by the measurement model and was sufficient to provide a solid foundation for the assessment of the structural relationships (Romandini *et al.*, 2021).

Table 7: HTMT discriminant validity

Construct_1	Construct_2	HTMT	Below_0_85	Below_0_90
DHL	CSPA	0.466	Yes	Yes
DHL	AASB	0.471	Yes	Yes
CSPA	AASB	0.579	Yes	Yes

HTMT values were easily below threshold conservative values for discriminant validity. The DHL–CSPA ratio was 0.466, DHL–AASB was 0.471, and CSPA–AASB was 0.579. These values suggest that there was little conceptual overlap between the latent variables and that the three reflective constructs were empirically distinguishable and that the results of the structural analysis were not likely to be due to this conceptual overlap.

Structural Model Assessment

Inner VIF values ranged from 1.000 to 1.334. All values were far below levels normally associated with

Table 8: Inner collinearity VIF

Outcome	Predictor	Inner_VIF
AMRK	DHL	1
CSPA	DHL	1.154
CSPA	AMRK	1.154
AASB	DHL	1.334
AASB	AMRK	1.181
AASB	CSPA	1.258

problematic multicollinearity. The estimates for DHL and AMRK predicting CSPA were 1.154, while predictors of AASB ranged from 1.181 to 1.334. The structural coefficients can therefore be interpreted without evidence that predictor collinearity materially distorted the path estimates.

Table 9: Explanatory power

Endogenous_Construct	R_Squared	Adjusted_R_Squared	Complete_Cases
AMRK	0.133	0.132	560
CSPA	0.205	0.202	560
AASB	0.358	0.354	560

The model accounted for 13.3% of the variance in AMR knowledge, 20.5% of the variance in confidence in seeking to speak to a professional for advice on antibiotics, and 35.8% of the variance in appropriate antibiotic-seeking behaviour. Adjusted values were virtually the same. This overall combination of the informational, knowledge and confidence pathways explained a proportion of variation that was meaningful for the behavioural outcome (Alima *et al.*, 2023).

Table 10: F-squared effect sizes

Outcome	Predictor	R2_Full	R2_Without_Predictor	F_Squared
AMRK	DHL	0.133	0	0.154
CSPA	DHL	0.205	0.081	0.156
CSPA	AMRK	0.205	0.186	0.023
AASB	DHL	0.358	0.328	0.047
AASB	AMRK	0.358	0.33	0.043
AASB	CSPA	0.358	0.237	0.187

The f-squared results show that DHL had an effect size of 0.154 on AMRK and 0.156 on CSPA. The CSPA contribution by the AMRK was lower at 0.023. The AASB predictor-specific effect size of 0.187 was the largest, while the effects of DHL and AMRK were smaller (0.047 and 0.043). This is in line with the role of professional-advice confidence as its largest proximal predictor in the model.

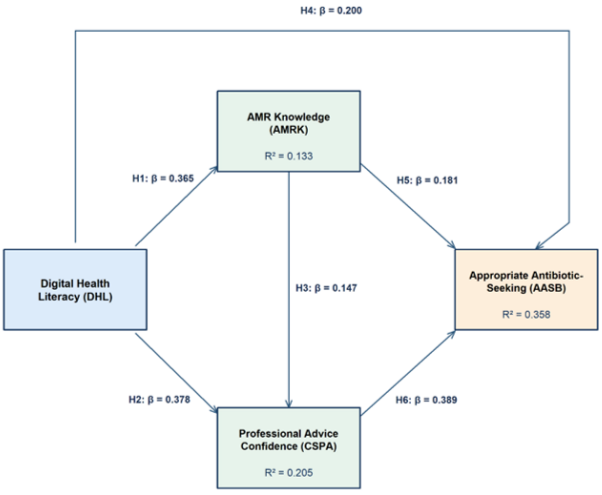


Figure 2: Structural model results with standardized path coefficients (β) and R^2 values.

Direct Effects, Mediation, and Hypothesis Testing

All six direct hypotheses were statistically supported. DHL was positively associated with AMRK (β = 0.3652) and CSPA (β = 0.3782). AMRK had a positive relationship

Table 11: Direct effects and hypothesis testing

Hypothesis	Path	Estimate	Bootstrap_SE	T_Value	P_Value	CI_2_5	CI_97_5	Decision	Bootstrap_N
H1	DHL -> AMRK	0.3652	0.0357	10.2261	0.001	0.294	0.4338	Supported	2000
H2	DHL -> CSPA	0.3782	0.0383	9.8725	0.001	0.3032	0.4558	Supported	2000
H3	AMRK -> CSPA	0.1467	0.0399	3.6735	0.001	0.0667	0.223	Supported	2000
H4	DHL -> AASB	0.2003	0.0405	4.9481	0.001	0.1215	0.28	Supported	2000
H5	AMRK -> AASB	0.1807	0.0359	5.0346	0.001	0.1079	0.2515	Supported	2000
H6	CSPA -> AASB	0.3889	0.0368	10.5549	0.001	0.3159	0.463	Supported	2000

with CSPA (β = 0.1467). All three predictors were also positively associated with AASB: DHL (β = 0.2003), AMRK (β = 0.1807), and CSPA (β = 0.3889). Each 95% bootstrap confidence interval did not contain the zero and each p-value was 0.001. CSPA had the highest direct coefficient for the behavioural outcome (Bert *et al.*, 2022).

Table 12: AMR knowledge mediation

Effect	Interpretation	Estimate	Bootstrap_ SE	T_Value	P_ Value	CI_2_5	CI_97_5	Decision	Bootstrap_N
H7_AMRK_ Mediation	H7: DHL -> AMRK -> AASB	0.066	0.015	4.4016	0.001	0.0382	0.0989	Positive effect supported	2000
H4	Direct effect: DHL -> AASB	0.2003	0.0405	4.9481	0.001	0.1215	0.28	Positive effect supported	2000
DHL_Total_ Effect	Total effect: DHL -> AASB through all modelled paths	0.4342	0.0342	12.7104	0.001	0.3643	0.4991	Positive effect supported	2000

The mediation hypothesis presented was validated. The indirect DHL → AMRK → AASB effect was positive and significant (β = 0.0660, 95% CI 0.0382–0.0989, p = 0.001). The direct DHL → AASB effect was also significant, demonstrating that AMR knowledge explained some of the relationship between digital health literacy and appropriate behaviour, but not all. This combined DHL influence on AASB for all modelled pathways was 0.4342.

Table 13: Exploratory indirect effects

Effect	Path	Estimate	Bootstrap_SE	T_Value	P_Value	CI_2_5	CI_97_5	Bootstrap_N
DHL_CSPA_AASB	DHL -> CSPA -> AASB	0.1471	0.0209	7.0499	0.001	0.1084	0.1902	2000
DHL_AMRK_CSPA_ AASB	DHL -> AMRK -> CSPA -> AASB	0.0208	0.0065	3.2174	0.001	0.0091	0.0343	2000
DHL_Total_Indirect	All modelled indirect DHL -> AASB paths	0.2339	0.0256	9.1487	0.001	0.1857	0.2867	2000

A set of exploratory indirect-effect analysis uncovered additional pathways besides the prespecified AMRK mediation. The following pathways, DHL → CSPA → AASB and DHL → AMRK → CSPA → AASB were significant with values of 0.1471 and 0.0208 respectively. The total effect of DHL on AASB modelled as 0.2339. It may appear that there was a correlation between digital health literacy and behavioural change both in terms of factual knowledge and confidence in communication with qualified health professionals.

Table 14: Summary of hypothesis decisions

Hypothesis	Proposed_Relationship	Estimate	P_Value	CI_2_5	CI_97_5	Decision
H1	DHL positively associated with AMRK	0.3652	0.001	0.294	0.4338	Supported
H2	DHL positively associated with CSPA	0.3782	0.001	0.3032	0.4558	Supported
H3	AMRK positively associated with CSPA	0.1467	0.001	0.0667	0.223	Supported
H4	DHL positively associated with AASB	0.2003	0.001	0.1215	0.28	Supported
H5	AMRK positively associated with AASB	0.1807	0.001	0.1079	0.2515	Supported
H6	CSPA positively associated with AASB	0.3889	0.001	0.3159	0.463	Supported
H7	AMRK mediates the DHL–AASB relationship	0.066	0.001	0.0382	0.0989	Supported

If the hypothesis summary shows a fully supported structural pattern, there is no need for further testing and the hypothesis is supported. H1–H6 were found to be positively supported direct relationships and H7 was found to be a positive AMR-knowledge mediation relationship. The results obtained from the empirical studies reflect a high degree of consistency in the direction of the coefficients, p-values and confidence intervals across hypothesis tests; and although the data are cross sectional, the empirical findings are relatively close to the conceptual framework proposed (Ahmed *et al.*, 2020).

Discussion

The results offer a unified perspective on the relationships between digital capability, factual knowledge and confidence in consulting with antibiotic seeking behaviours of parents and caregivers. The findings from the measurement instruments show first that the three reflective constructs were reliably represented. Digital health literacy, confidence in seeking professional advice and seeking appropriate antibiotic advice were related but distinct domains supported by strong outer loadings, high internal consistency, adequate AVE and low HTMT ratios. This difference is significant because when interventions are delivered without regard for the difference, it can result in the failure to achieve desired outcomes (Paul *et al.*, 2022).

The digital health literacy had a significant positive correlation with AMR knowledge. This outcome contributes to the hypothesis that finding and critically analysing health information online can aid caregivers to build accurate knowledge about antibiotics and resistance. This correlation is plausible as digitally literate parents are more likely to identify credible health information from anecdotal or promotional information. The R-squared of AMRK, however, was 0.133, meaning that only part of the factual knowledge is explained by digital health literacy. Education, prior experiences with health care providers, messages from health care providers, social networks and prior antibiotic related experiences are also likely to influence AMR awareness. Digital literacy should thus be seen as but one element of a knowledge landscape (Dantuluri *et al.*, 2023).

The confidence in seeking professional advice was also positively associated with digital health literacy. This connection proved to be more powerful than the linkage between AMRK and CSPA. Analogue suggests that the practical benefits for the students go beyond just gathering facts. Parents with the ability to search, compare and appraise information may be better prepared to describe the symptoms and to ask questions in the consultation that are focussed. Having credible digital information that can lower uncertainty prior to reaching out to a professional and can help caregivers see which information is pertinent to share. In parallel, AMR knowledge also had an independent effect on CSPA, demonstrating that knowledge of antibiotic-related facts remains relevant in terms of confidence in antibiotic-related discussions.

The strongest direct predictor was confidence in professional advice for appropriate antibiotic seeking behaviour. Path coefficient 0.3889 and f squared value 0.187 were larger compared to the path coefficient and f squared value of digital health literacy and AMR knowledge. The finding brings to the fore the significance of translating knowledge into interactional capability. Parents might be aware that unnecessary antibiotics are an issue, but may still informally request antibiotics if they feel they are not able to talk to providers or resist family pressure (Hicks *et al.*, 2021). Confidence seems to move information to action, it appears to support consultation, discussion of symptoms, clarity and acceptance of professional assessment.

Even after adding CSPA, the direct effects of DHL and AMRK on AASB were still significant. This signals a number of complementary mechanisms of appropriate antibiotic seeking behaviour. Digital literacy can have an impact at every level in terms of source evaluation and determining when to engage a professional assessment. Factual knowledge about AMR may dampen unrealistic expectations of antibiotics. Consultation confidence can help enable the necessary tangible shifts in behaviour needed to shift the beliefs into safer care seeking. This makes its meaningful R-squared for AASB of 0.358, indicating that there is still significant behavioural variation that falls outside the model.

The mediation results lend more information. Among the prespecified indirect path from digital health literacy to appropriate behaviour via AMR knowledge, it showed positive value and was statistically significant. Given that the direct DHL-to-AASB path was also important, the evidence suggests a partial mediation process and is inconsistent with a fully mediated process. This correlation to behaviour seems to be partially mediated by digital health literacy in relation to better knowledge about AMR, as knowledge does not exhaust this correlation. These exploratory findings support this interpretation. The indirect effect from the DHL to the CSPA to the AASB was greater than the AMRK mediation effect, as was the sequential pathway through AMRK and CSPA.

The results, collectively, imply that the information quality, factual knowledge and confidence in professional matter should be viewed together. A programme that disseminates only AMR facts can foster knowledge but not tackle the assessment of internet information by the caregivers nor the interaction with health care professionals. Similarly, digital-literacy training that does not include antibiotic-specific content may leave important misconceptions unresolved. Hence, the best possible explanation for the current model is integrative; parents might be more able to obtain proper antibiotics when they are accessible with credible digital information, core AMR principles, and the ability to communicate with competent professionals (Akhtar *et al.*, 2021).

The descriptive findings are also helpful in providing

context. Individual AMR items had generally a 50% correct response and the mean knowledge score was 3.65 out of seven. Meanwhile, nearly half of respondents reported taking over 30 minutes to access a qualified health care provider and more than one in four of them were sometimes or always having trouble paying for consultation. These conditions may limit the extent of translation of knowledge and confidence into behaviour. Thus, behavioural interventions should be read in the light of structural access conditions and not be presumed to be simply a problem of information.

Practical and Policy Implications

The results have implications for antibiotic stewardship efforts and digital-health communication. Awareness messages cannot be a sole basis for parent-oriented programmes. Training on digital literacy should educate the carers to find trustworthy health information, to know how to compare conflicting information and to understand that some information on the internet cannot replace clinical evaluation. Common misconceptions should be a focus of AMR education, for example viral illness and the unnecessary use of antibiotics or leftover medicines or following professional instructions.

The high levels of professional-advice confidence also indicate a need for parents to be ready for consultation in interventions. Short communication tools may facilitate communication between the caregiver and the prescriber regarding the symptoms, antibiotic need/necessity, clarification, and concerns of the caregiver, without requiring a specific medication. Health professionals can support this journey by giving clear explanations where appropriate when antibiotics are not used. Since affordability and travel difficulties existed in the sample, interventions that target improving accessible, trusted, and timely professional advice, should best be complemented by informational interventions. Digital channels could be specifically helpful in linking parents to credible advice, instead of just increasing their number of encounters with unconfirmed health information (Alima *et al.*, 2023). Stewardship messages need to be created at a policy level for digital platforms where parents typically look for answers and funnel the remainder to easily accessible, competent, and local child-health questions and advice services. Future stewardship platforms might also include short prompts for decision-making before antibiotic purchase, to ensure source credibility, evaluation by a professional steward and to reduce reliance on leftover meds.

Limitations and Future Research

There are some restrictions which might limit the interpretation. The cross-sectional design cannot determine temporal order and causal relationships and behaviour was self-reported instead of being independent observed. There is a meaningful but incomplete relationship between the model and behavioural variance, potentially important additional factors include access, social norms, previous prescribing experiences, severity of illness and provider characteristics. Future longitudinal and intervention studies are warranted to determine if the digital health literacy and confidence in consultation changes result in changes in antibiotic seeking behavior and to explore the differences among the subgroups in different socioeconomic and geographic conditions.

CONCLUSION

The research demonstrates that parents' digital health literacy has a positive relationship with proper antibiotic-seeking behavior for children's illness in Bangladesh in various ways. Knowledge of AMR, and confidence in seeking professional advice, was associated with digital literacy, as appropriate reported behaviour. AMR knowledge played a very high role in the mediation of the digital literacy-behaviour relationship and consultation confidence was found to be the strongest direct predictor of behaviour. The results indicate the need for an integrated strategy to antibiotic stewardship in the household. While enhancing factual knowledge of AMR is important, it is unlikely that this alone will be enough. Interventions should also enhance the capacity of caregivers to assess digital health information and increase their trust in interacting with qualified health information. This blend of approaches could help families better informed and professional decisions around antibiotic use while removing the notion that treatment options that are accessible online are safe.

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