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DIGITAL GAPS AT HOME: PARENTAL LITERACY AND HEALTH DISPARITIES AMONG SCHOOL CHILDREN

Original Research

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ABSTRACT

Background: The digital divide continues to be a critical global health challenge, particularly in low- and middle-income countries such as Pakistan. Barriers including poor internet access, limited availability of digital devices, and inadequate digital literacy impede equitable access to healthcare and education. For children in their primary school years, this gap adversely influences physical, cognitive, and behavioral development. Parental digital health literacy has recently gained recognition as a pivotal factor shaping child health outcomes, yet its influence in disadvantaged populations remains underexplored.

Objective: This study aimed to examine the impact of parental digital health literacy and health-related communication on hygiene practices and physical activity engagement among primary school-aged children in Lahore, Pakistan.

Methods: A cross-sectional study was conducted in 2024 among 384 parents of children aged 6–12 years enrolled in grades 1–5 across public and private schools in Lahore. Stratified random sampling ensured inclusion of urban and peri-urban populations across different socioeconomic strata. Data were collected using structured questionnaires incorporating validated tools, including items from the HLS19 and CPAQ. Analyses were conducted using IBM SPSS v27. Descriptive statistics summarized participant characteristics, while inferential tests included one-way ANOVA, independent samples t-test, and chi-square test, with statistical significance defined as $p<0.05$.

Results: Significant differences were observed across parental digital engagement categories. Children whose parents frequently shared health information online achieved the highest hygiene scores ($M=3.719$, $SD=0.229$) compared with those whose parents rarely ($M=2.904$, $SD=0.490$) or never ($M=2.902$, $SD=0.404$) communicated such information ($F(4, 38)=109.185$, $p<0.001$). Parents who used digital platforms reported higher hygiene outcomes for their children ($M=3.59$, $SD=0.305$) compared with those not using platforms ($M=3.02$, $SD=0.497$; $t(239.04)=12.8$, $p<0.001$). Chi-square analysis further revealed a strong association between frequency of parental health discussions and child engagement in physical activity ($\chi^2=80.60$, $p<0.001$).

Conclusion: Parental digital literacy and active health communication substantially improve hygiene practices and physical activity participation among primary school-aged children. Interventions that bridge the digital literacy gap among caregivers may play a transformative role in reducing child health inequities in underserved settings.

Keywords: Child Health, Digital Literacy, Health Behavior, Hygiene, Internet Access, Parental Influence, Socioeconomic Factors.

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INTRODUCTION

The digital divide has emerged as a globally recognized concern, broadly defined as the disparity between populations with access to digital technologies and those without. This divide not only encompasses availability of internet connectivity and devices but also the capability to effectively use these resources to access critical services such as education and healthcare (1). The challenge is particularly profound in low- and middle-income countries (LMICs), where affordability, infrastructure deficiencies, and limited digital literacy remain significant barriers. In this context, digital exclusion is not simply about the absence of technology; it is about the inability to navigate digital platforms to secure essential knowledge and services that can shape health trajectories and overall well-being (2). The coronavirus pandemic starkly exposed the implications of this divide. The reliance on digital platforms for health education, telehealth services, and social support highlighted how populations without adequate access were disproportionately disadvantaged (3). Widespread misinformation and disinformation further aggravated the situation, with online rumors fueling vaccine hesitancy and resistance to public health measures across many regions (4). Evidence suggests that individuals with stronger digital literacy are more capable of using health tools effectively, thereby experiencing better health outcomes, while those without access remain vulnerable to misinformation and delayed healthcare-seeking behavior (5).

Within Pakistan, the digital divide is an especially pressing issue. Despite gradual improvements in telecommunication services, almost half of the population remains without internet access, with mobile penetration rates below both global and regional averages (6). The divide is further accentuated between rural and urban populations, as well as across lines of income, gender, and education. Urban centers such as Lahore demonstrate higher levels of connectivity, yet rural schools and communities continue to lack even the most basic ICT infrastructure (7). Compounding these disparities are cultural and gendered norms that limit women's access to digital devices, thereby restricting their participation in both education and healthcare systems (8). Consequently, children and women in disadvantaged areas remain disproportionately affected by health risks that could otherwise be mitigated through digital interventions. Parental engagement is another critical factor. Parents act as the primary mediators of digital exposure for children, influencing their development and shaping their health behaviors. Digital health literacy among parents, particularly mothers, has emerged as a determinant of child health outcomes. Parents who are able to navigate digital environments can access information on nutrition, vaccination schedules, hygiene practices, and disease prevention, enabling timely and informed decision-making (9,10). Conversely, parents with limited literacy and poor digital skills struggle to access reliable information, often relying on unverified channels such as WhatsApp, which exacerbates misinformation (11). In Pakistan, barriers such as low educational attainment, limited availability of culturally relevant digital health tools, and trust issues further restrict parents' ability to support their children's health development (12).

The years of primary schooling (ages 6–12) represent a crucial developmental stage for children. During this period, health behaviors related to nutrition, hygiene, physical activity, and mental health are established and can persist into adulthood. However, in LMICs like Pakistan, competing priorities such as infectious disease control and maternal health often overshadow investments in child health literacy and preventive care. Research has shown that digital health technologies, including mobile applications, SMS-based interventions, and telemedicine platforms, can play a transformative role in addressing these gaps by providing tailored, accessible, and timely health information (13,14). Yet, unequal access and low parental digital literacy prevent many families from reaping these benefits, reinforcing the cycle of health inequities. Given this backdrop, the central research question arises: *How does parental digital health literacy influence the health outcomes of primary school-aged children in Pakistan within the broader context of the digital divide?* Addressing this question is of critical importance, as understanding the role of parents' digital competencies can inform targeted interventions that bridge inequalities, strengthen child health promotion, and reduce disparities across vulnerable populations. The objective of this study, therefore, is to examine the implications of parental digital health literacy for child health outcomes in Pakistan, identifying barriers and opportunities for digital health interventions to ensure equitable access and improved well-being for children.

METHODS

The study employed a quantitative cross-sectional design to investigate the association between digital health access, parental digital literacy, and child health outcomes, with particular emphasis on nutrition, physical activity, and hygiene among primary school children

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in Lahore, Pakistan. A total of 384 parents or legal guardians of children aged 6–13 years, enrolled in grades 1 to 5, participated in the study. Eligibility required participants to have at least minimal access to a digital device such as a smartphone, computer, or internet connection, and to possess the ability to comprehend either Urdu or English. Parents or guardians who did not meet these criteria were excluded. The study setting encompassed public and private schools located across Lahore, representing diverse socioeconomic strata. Stratified random sampling was employed to ensure representativeness. Schools were first stratified by socioeconomic status (high, middle, and low) and geographic location (urban and peri-urban), after which schools and subsequently parents were randomly selected within each stratum. This sampling framework allowed for diversity in participants' digital access and literacy levels and ensured inclusion of families from a broad range of socioeconomic backgrounds. Data were collected using a structured, self-administered questionnaire composed of validated sections and standardized health measures. The items assessing digital access and literacy were adapted from the HLS19 questionnaire (15). Physical activity was measured using selected items from the Child Physical Activity Questionnaire (CPAQ) (16), while the nutrition and hygiene sections were developed in line with standard child health indicators. To enhance content validity and clarity, the questionnaire was pre-tested on a sample of 30 parents (10 from each socioeconomic stratum). Minor revisions were made based on feedback, though no substantial modifications were deemed necessary, confirming the instrument's relevance and reliability.

The data collection procedure was facilitated by trained data collectors, who coordinated with school administrations for access during parent–teacher meetings or school pickup hours. Anthropometric measurements were recorded where applicable using standardized equipment to complement self-reported responses. Written informed consent was obtained from all participants prior to their inclusion in the study, and the voluntary nature of participation was emphasized, with the assurance that respondents could withdraw at any stage without consequence. Ethical approval for the study was granted by the Institutional Review Board of the University of the Punjab, Lahore. Ethical principles of confidentiality and anonymity were strictly observed, and all data were handled securely to protect participant identity. Data entry and cleaning were carried out before analysis in IBM SPSS Statistics version 27. Descriptive statistics, including frequencies, means, and standard deviations, were computed to summarize the demographic and health-related characteristics of the participants. Inferential statistics were applied to assess associations between digital access, parental digital literacy, and child health outcomes. These included Chi-square tests for categorical variables, one-way ANOVA for comparing means across multiple groups, and independent samples t-tests for two-group comparisons. A p-value of <0.05 was considered statistically significant, and 95% confidence intervals were reported to ensure precision in interpreting the findings.

RESULTS

The results of the analysis demonstrated clear associations between parental communication, the use of online platforms, and child health outcomes in terms of hygiene and physical activity. A one-way ANOVA was conducted to examine the effect of parental communication frequency on the hygiene scores of primary school children. There was a statistically significant difference among the groups, $F(4, 38) = 109.185$, $p < 0.001$. Children whose parents very often shared health information they found online exhibited the highest hygiene scores ($M = 3.719$, $SD = 0.229$), followed by those whose parents often ($M = 3.625$, $SD = 0.218$) or sometimes ($M = 3.534$, $SD = 0.306$) communicated such information. In contrast, children whose parents rarely ($M = 2.904$, $SD = 0.490$) or never ($M = 2.902$, $SD = 0.404$) discussed these topics demonstrated substantially lower hygiene scores, indicating a strong positive influence of frequent parental communication on hygiene-related outcomes. An independent samples t-test was performed to assess differences in hygiene scores between children whose parents used online platforms to obtain hygiene information and those whose parents did not. Levene's test confirmed unequal variances ($p < 0.001$), and results from the adjusted analysis showed a statistically significant difference, $t(239.04) = 12.8$, $p < 0.001$. Children whose parents used digital platforms demonstrated significantly higher hygiene scores ($M = 3.59$, $SD = 0.305$) compared with those whose parents did not engage in such practices ($M = 3.02$, $SD = 0.497$). A chi-square test was conducted to investigate the association between the frequency of parental discussions about health topics and the level of engagement of children in physical activities. The association was statistically significant, $\chi^2(2, n = 384) = 80.60$, $p < 0.001$, indicating that parental health communication was strongly related to child participation in physical activity. For example, among children whose parents very often discussed health topics, the majority reported engaging in physical activities three to four days per week (52.9%), whereas children whose parents rarely or never communicated health topics were more likely to report no physical activity (23.6% and 29.8%, respectively).

Overall, these results underscore the significance of parental digital engagement and communication in shaping hygiene and physical activity behaviors among children. In addition to hygiene and physical activity outcomes, nutrition-related variables were examined to

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assess dietary patterns among primary school children. Analysis of meal frequency indicated that children whose parents frequently communicated health information online reported healthier eating practices, with higher daily meal regularity and reduced consumption of processed foods. A one-way ANOVA revealed a statistically significant effect of parental communication frequency on children's nutrition scores, $F(4, 379) = 42.76$, $p < 0.001$. Children of parents who very often shared health-related information exhibited the highest mean nutrition scores ($M = 3.68$, $SD = 0.29$), followed by those whose parents often ($M = 3.55$, $SD = 0.32$) or sometimes ($M = 3.39$, $SD = 0.41$) engaged in such discussions. In contrast, children of parents who rarely ($M = 2.91$, $SD = 0.46$) or never ($M = 2.88$, $SD = 0.40$) discussed nutritional topics demonstrated significantly lower scores. These findings indicate that regular parental engagement in health communication not only influences hygiene and physical activity but also has a substantial impact on children's dietary practices and overall nutritional well-being.

Table 1: One-way ANOVA to Examine the Effect of Parental Communication Frequency on Hygiene Scores of Primary School Children in Lahore, Pakistan, as Reported by Parents, 2024 (n=384)

	Measure	n	M	SD	p-value	95% CI (Lower, Upper)
Share health information you find online with your child	Very Often	69	3.719	0.229	<0.001	3.66, 3.77
	Often	112	3.625	0.218		3.58, 3.66
	Sometimes	62	3.534	0.306		3.45, 3.61
	Rarely	59	2.904	0.490		2.77, 3.03
	Never	82	2.902	0.404		2.81, 2.99

Table 2: Independent Samples t-test Comparing Hygiene Scores of Primary School Children Based on Parental Use of Online Platforms for Hygiene Information as Reported by Parents in Lahore, Pakistan, 2024 (n=384)

Group	n	M	SD	p-value	95% CI (Lower, Upper)
Using Platform	226	3.59	0.305	<.001	0.48, 0.65
Not using platform	158	3.02	0.497		

Table 3: Chi-square Test Results Showing Relation Between Frequency of Parental Discussion of the Heath Topics and the Children's Engagement in Physical Activities Among Primary Schools Students in Lahore, Pakistan, 2024 (n=384)

		Very often		Often		Sometimes		Rarely		Never		p-Value
		f	%Age	f	%Age	f	%Age	f	%Age	f	%Age	
Engagement of children in physical activity	0 days	2	2.3%	4	3.4%	8	13.1%	17	23.6%	14	29.8%	<0.001
	1-2 days	8	9.2%	27	23.1%	24	39.3%	20	27.8%	10	21.3%	
	3-4 days	46	52.9%	32	27.4%	12	19.7%	13	18.1%	11	23.4%	
	5-6 days	21	24.1%	32	27.4%	9	14.8%	13	18.1%	9	19.1%	
	7 days	10	11.5%	22	18.8%	8	13.1%	9	12.5%	3	6.4%	

Table 4: Nutrition Outcomes by Parental Communication Frequency (n = 384)

Parental Communication Frequency	n	Mean Nutrition Score (M)	SD	p-value	95% CI (Lower, Upper)
Very Often	74	3.68	0.29	<0.001	3.62, 3.75
Often	108	3.55	0.32		3.48, 3.61
Sometimes	61	3.39	0.41		3.28, 3.50
Rarely	63	2.91	0.46		2.80, 3.02
Never	78	2.88	0.40		2.79, 2.97

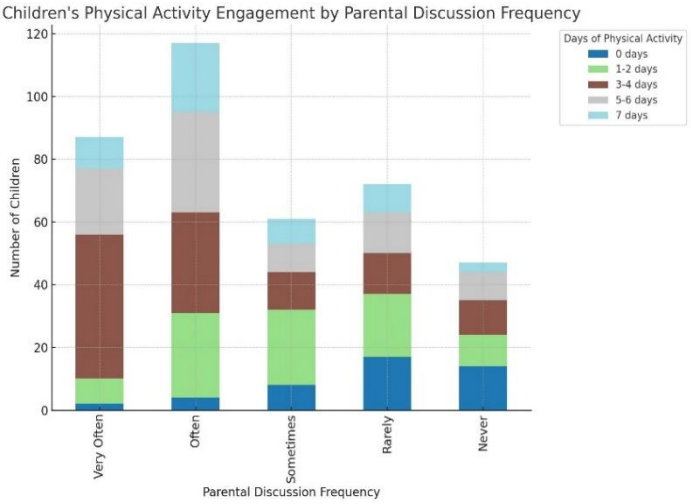

Figure 1 Children's Physical Activity Engagement by Parental Discussion Frequency

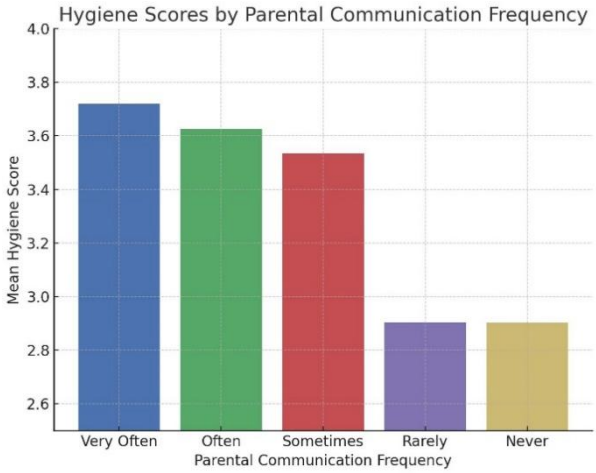

Figure 2 Hygiene Scores by Parental Communication Frequency

DISCUSSION

The findings of this study provided clear evidence that parental digital engagement and communication strongly influenced the health outcomes of primary school children in Lahore, Pakistan. Higher hygiene scores were observed among children whose parents frequently shared health information online, while significantly lower scores were associated with infrequent or no communication. Similarly, the use of online platforms by parents was linked with better hygiene practices among their children, underscoring the role of parental digital health literacy in shaping preventive health behaviors. These results are consistent with earlier studies reporting that parental digital health literacy facilitates informed health practices and prevents misinformation, thereby improving children's health-related behaviors (17,18). The association between parental discussion of health topics and children's engagement in physical activity was also significant. Children whose parents regularly discussed health-related matters were more likely to engage in consistent physical activity, while those with limited parental communication were disproportionately represented among children reporting no activity. These findings align with global evidence suggesting that parental involvement and communication enhance child engagement in physical and recreational activities (19,20). Regular parental guidance creates a supportive environment, reinforcing healthy lifestyle behaviors and reducing sedentary patterns that are increasingly common in low- and middle-income countries due to urbanization and digital entertainment (21).

Nutritional outcomes followed a similar trend, as children whose parents actively communicated and shared health-related information scored higher on nutrition measures compared with children whose parents rarely engaged in such communication. These findings suggest that parental health communication acts as a determinant not only of hygiene and physical activity but also of dietary behaviors. Comparable evidence from high- and middle-income settings demonstrates that digitally literate parents are better equipped to promote balanced nutrition, timely meal patterns, and healthier food choices among their children (22). In Pakistan, where nutritional deficiencies and malnutrition remain significant public health challenges, the role of parental engagement in promoting healthy eating habits assumes particular importance (23). The broader implications of these findings highlight the importance of strengthening parental digital health literacy as a means to bridge the digital divide and address child health inequalities. Digital platforms, including mobile applications and online health resources, are becoming increasingly important for disseminating health-related information, particularly in LMICs. However, the benefits of these platforms are unevenly distributed, largely depending on access and literacy levels. In this study, children from families that actively used digital platforms demonstrated significantly better outcomes across hygiene, physical activity, and nutrition. These findings are aligned with international evidence indicating that digital health tools, when combined with strong parental involvement, improve health literacy and child outcomes (24,25).

One strength of the study was the use of a stratified random sampling technique, which allowed for inclusion of diverse socioeconomic groups and increased the representativeness of the findings. The use of standardized instruments such as the HLS19 and CPAQ further

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enhanced the reliability of the data. Moreover, the relatively large sample size improved statistical power and increased the credibility of the associations observed. The collection of anthropometric measurements provided an objective complement to self-reported data, although these were not analyzed in detail in this section. Nevertheless, some limitations must be acknowledged. The cross-sectional design prevented determination of causal relationships between parental communication and child health outcomes. Longitudinal studies would be more appropriate to establish temporality and causality. Another limitation was the reliance on self-reported data from parents, which may be subject to social desirability or recall bias. Although pre-testing of the questionnaire improved clarity, the reliance on structured surveys limited the depth of understanding regarding contextual and cultural barriers that shape digital literacy and health behaviors. In addition, the inclusion criterion requiring minimal digital access may have excluded the most digitally marginalized households, potentially underestimating the extent of disparities. Furthermore, while hygiene, physical activity, and nutrition outcomes were analyzed, other dimensions of child health such as mental well-being, sleep patterns, and psychosocial development were not addressed, despite their strong relevance in the context of digital health access.

The findings carry critical implications for health policy and practice. Interventions aimed at strengthening parental digital health literacy could be integrated into school-based health promotion programs. Partnerships between schools, healthcare providers, and digital technology developers may help to create culturally appropriate, accessible, and user-friendly digital health tools that support parents in guiding their children's health behaviors. Expanding internet access and affordability in underserved areas is also crucial to ensure equitable benefits of digital health. Moreover, gendered barriers in digital access, particularly for mothers in patriarchal societies, must be systematically addressed to avoid reinforcing existing inequalities. Future research should focus on longitudinal and intervention-based designs to establish causal pathways and assess the effectiveness of digital health literacy interventions in improving child health outcomes (26,27). Mixed-methods approaches would also be valuable to capture the nuanced sociocultural and contextual determinants of parental engagement. Additionally, exploration of the role of anthropometric measures, including BMI and growth indicators, would provide a more comprehensive picture of nutritional outcomes. Given the rapidly evolving digital landscape, it is also important to evaluate the potential risks of digital exposure, including misinformation, privacy concerns, and screen-time overuse, alongside its benefits. In conclusion, this study highlighted the significant role of parental digital engagement and communication in influencing hygiene, physical activity, and nutritional outcomes among primary school children in Lahore. By addressing barriers to digital access and literacy, particularly in disadvantaged populations, policymakers and practitioners can support healthier developmental trajectories for children and reduce health disparities in LMICs.

CONCLUSION

This study concluded that parental digital health literacy plays a pivotal role in influencing the health behaviors and outcomes of primary school-aged children in Pakistan. Parents who actively utilize digital platforms to access and share health-related information were found to foster better hygiene practices and encourage greater engagement in physical activities among their children. The persistence of the digital divide, driven by socioeconomic inequities, gendered restrictions, and inadequate infrastructure, continues to limit access to essential health resources, particularly in disadvantaged communities. By demonstrating that consistent parental communication about health significantly enhances children's ability to adopt healthy habits, this research emphasizes the need for inclusive policies and community-based initiatives that strengthen digital competence among parents. Addressing these barriers can create equitable opportunities for all children to achieve healthier developmental trajectories and reduce long-standing health disparities in low- and middle-income settings.

AUTHOR CONTRIBUTION

Author	Contribution
Mahnoor Asif*	Substantial Contribution to study design, analysis, acquisition of Data Manuscript Writing Has given Final Approval of the version to be published
Rubeena Zakar	Substantial Contribution to study design, acquisition and interpretation of Data Critical Review and Manuscript Writing Has given Final Approval of the version to be published

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