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Science Literacy and Healthy Living as Determinants of Family Health within the Household Ecology Framework

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Abstract: This study examines how science literacy and healthy living behaviors jointly shape family health within a household ecology framework. Using a non-experimental, cross-sectional design, we surveyed 40 mothers from an urban area in western Indonesia. Validated questionnaires (CVI = 0.86; Cronbach's $\alpha \geq 0.70$) measured science literacy, healthy living, and family health. Data were analyzed with Pearson's correlations and multiple linear regression after meeting parametric assumptions (Shapiro–Wilk $p > 0.05$; VIF = 1.54; Durbin–Watson = 1.85; no heteroscedasticity). Correlations were positive and significant: science literacy with family health ($r = 0.65$, $p < 0.01$), healthy living with family health ($r = 0.70$, $p < 0.01$), and science literacy with healthy living ($r = 0.58$, $p < 0.01$). The regression model was significant, $F(2,37) = 18.45$, $p < 0.001$, explaining 50% of the variance in family health ($R^2 = 0.50$). Both predictors contributed uniquely (β_science literacy = 0.35, $p = 0.007$; β_healthy living = 0.45, $p = 0.001$), with healthy living showing the stronger effect. Findings underscore that strengthening science literacy is necessary but insufficient unless translated into day-to-day healthy practices. We recommend community-based programs that couple non-formal science education with practice-oriented training (nutrition, sanitation, household hygiene). Future studies should employ larger, longitudinal samples and incorporate socio-economic and environmental covariates.

Keywords: family health; healthy living; household ecology; science literacy; urban Indonesia.

Introduction

Family health serves as a fundamental pillar of sustainable human development, with mothers playing a central role in safeguarding the well-being of household members through the management of nutrition, sanitation, and home-based disease prevention. The effectiveness of this role is primarily determined by science literacy, the ability to understand and apply basic scientific concepts in everyday life, and the adoption of sustainable, healthy living practices. Within the framework of household ecology, health is not merely perceived as an individual condition but as the result of complex interactions among biological, environmental, and social factors. The Word Health Organization (2023) reports that more than 60% of diseases in developing countries are associated with poor sanitation and unhealthy lifestyles. UNESCO (2021) highlights that family-level science literacy is essential to address modern health challenges such as malnutrition, obesity, and degenerative diseases. These findings highlight the urgent need to integrate science literacy and healthy living at the household level as part of public health strategies.

Recent empirical evidence further reinforces the importance of science literacy for family health. Science literacy–based education on clean and healthy living behaviors has significantly improved mothers'

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knowledge and household health practices (Ashar, 2022; Rukmini et al., 2024; Samerski, 2019) found a strong positive association between health literacy and PHBS implementation, indicating that scientific understanding directly affects health-related behaviors. Other studies conducted during the COVID-19 pandemic reported that family health literacy levels in Indonesia remain at a moderate level, signaling the need for more intensive interventions to strengthen this capacity (Nurhaeni, 2022). Strengthening science literacy and healthy living among mothers is not only relevant for improving family health status. Still, it is crucial for enhancing human resource quality and environmental sustainability in the modern era.

Contemporary research has provided robust evidence that science literacy significantly improves individual and family health outcomes. Several studies have emphasized that scientific understanding, particularly regarding nutrition, sanitation, and environmental health, directly impacts healthy living behaviors (Ashar, 2022; Samerski, 2019). Mansour and Alfojery (2025) and Brady et al. (2023) found that science-based educational interventions significantly enhance hygienic practices among families in urban and rural contexts. Similarly, Bozorg-Haddad et al. (2021) reported that integrating science literacy into family empowerment programs reduces environmentally related illnesses such as diarrhea and acute respiratory infections. These findings suggest that science literacy has broad practical implications, extending beyond formal education to public health.

International studies also corroborate these findings. For instance, Gu and Feng (2022) identified a significant correlation between science literacy and preventive health behaviors during the COVID-19 pandemic in China, highlighting the importance of scientific knowledge for evidence-based decision-making. In Southeast Asia, Komro et al. (2011) documented that community-based health literacy programs improve awareness and household-level practices for preventing infectious diseases. Although PHBS programs have been widely implemented in Indonesia, Nurhaeni (2022) revealed that family health literacy levels remain uneven, with many mothers falling into the moderate category. Recent literature suggests a positive trend in which education and science literacy contribute to healthy behaviors; however, their effectiveness is shaped by socio-cultural contexts, information access, and policy support.

Despite the growing body of literature demonstrating positive associations between science literacy, healthy living, and family health status, several research gaps remain. Studies in Indonesia have generally assessed PHBS programs or general health knowledge descriptively, without examining science literacy as a measurable and evidence-based predictive variable (Nurhaeni, 2022; Samerski, 2019). Moreover, ecological aspects of the household, such as water quality, waste management, and residential density, that contribute to family health status are often overlooked, even though domestic environmental factors have been identified as critical health determinants (Ashar, 2022; Bozorg-Haddad et al., 2021; Rukmini et al., 2024). International research has also focused predominantly on pandemic contexts, providing limited attention to normal or long-term conditions, particularly in developing countries with high socio-cultural diversity. Furthermore, existing methodological approaches tend to be partial and descriptive, rarely exploring the unique combination of formal science education and evidence-based healthy living within a household ecology framework. Addressing these gaps is the primary motivation for the present study.

This study offers a novel contribution by integrating formal science literacy and healthy living practices within a household ecology framework, a combination of variables rarely examined simultaneously in the Indonesian context. Unlike most studies that have examined health literacy descriptively or partially (Nurhaeni, 2022; Samerski, 2019), this research quantitatively investigates the relationship between mothers' science literacy and evidence-based healthy living practices and their contribution to family health status. This approach extends the model of health determinants by including domestic environmental aspects such as sanitation, water quality, and household hygiene, which have been shown to influence public health (Ashar, 2022; Bozorg-Haddad et al., 2021). The study conducted in a post-pandemic context provides timely and relevant insights into how science literacy and healthy living can be long-term preventive strategies to improve human resource quality in developing countries. This novelty makes the study theoretically relevant for advancing the science literacy framework in family health and practically valuable for supporting community-based health programs and sustainable public health policies.

If these research gaps remain unaddressed, efforts to improve family health risk reduction and public health policies may lack a comprehensive scientific foundation. Low science literacy among mothers may lead to poor decision-making regarding nutrition, sanitation, and disease prevention, exacerbating the prevalence of environmentally transmitted diseases and malnutrition (WHO, 2023; UNESCO, 2021). Moreover, without science-based understanding, PHBS programs risk becoming ceremonial and unsustainable, as healthy behaviors are not properly internalized (Komro et al., 2011; Nurhaeni, 2022). In the long term, this could widen health disparities, reduce human resource quality, and

hinder progress toward achieving sustainable development goals, particularly those related to health and well-being. Therefore, addressing these gaps is an urgent step to ensure that family health strategies based on science literacy can be implemented effectively and contextually.

This study investigates the relationships between science literacy (proxied by mothers' formal science education), healthy living behaviors, and family health status within a household-ecology framework in an urban Indonesian setting. We address three research questions: (RQ1) the association between science literacy and family health; (RQ2) the contribution of healthy living behaviors to family health; and (RQ3) their joint effects estimated via multiple linear regression. In line with this design, the manuscript presents a single, integrated Results and Discussion section structured by these research questions, linking descriptive indices, bivariate correlations, and standardized coefficients to relevant theory and prior evidence. The objective is twofold: to advance scholarship on science-based health determinants by specifying how cognitive (literacy) and behavioral (routines) domains operate together in the domestic context, and to provide actionable implications for community programs and sustainable public health policy in comparable urban environments.

Method

Research Design

This study employed a quantitative approach with a non-experimental correlational design. This design was chosen as it aligns with the research objective of understanding and explaining the natural relationships between science literacy, as represented by mothers' formal educational attainment, and healthy living practices concerning family health status. A quantitative approach allows for objectively measuring variables using numerical data that can be analyzed scientifically. At the same time, a correlational design is appropriate because it enables the depiction of associations among variables without manipulating participant conditions (Creswell & Creswell, 2017).

The study is non-experimental because it focuses on describing existing relationships in the field as they naturally occur, rather than testing the effects of a treatment. Furthermore, a cross-sectional approach was adopted, in which data were collected at a single point in time to capture participants' conditions accurately and efficiently (Maier et al., 2023). This design is particularly relevant for science education and family health research, as it identifies empirical relationships that can inform the development of policies and science literacy–based intervention programs.

Population and Sample

The study population consisted of mothers responsible for managing family health and well-being. Participants were selected using purposive sampling based on the following criteria: (1) serving as the primary decision-maker regarding family nutrition, sanitation, and health; (2) having at least one family member living in the same household; and (3) providing voluntary consent to participate in the study.

A total of 40 participants were included. They resided in an urban area in western Indonesia and represented diverse socio-economic backgrounds. Most respondents were between 36 and 50 years old, most having completed higher education, followed by high school graduates. Only a small proportion had completed elementary or junior high school. Most participants reported having two to four dependents, reflecting typical urban family structures. A detailed summary of respondent characteristics is presented in Table 1.

Table 1. Characteristics of Research Participants (n = 40)

Characteristic	Category	Frequency (n)	Percentage (%)
Age (years)	< 25	2	5,0%
	25–35	12	30,0%
	36–50	18	45,0%
	> 50	8	20,0%
Educational level	Elementary School	2	5,0%
	Junior High School	4	10,0%
	Senior High School	14	35,0%
	Higher Education	20	50,0%
Number of dependents	1	4	10,0%
	2–4	28	70,0%
	> 4	8	20,0%

Most respondents were in the productive age range of 36–50 years (45%), and half had completed higher education (50%). In contrast, only a small proportion had completed elementary or junior high school (5% and 10%, respectively). This distribution is consistent with the characteristics of developed urban areas, where access to higher education tends to be relatively better. Most respondents reported having two to four dependents (70%), which is relevant to the context of mothers' roles in managing family health.

Research Instrument

The research instrument was systematically developed to measure three main variables: science literacy, healthy living behavior, and family health status. The development of questionnaire items was guided by recent literature and the study's objective of empirically examining the relationships among these variables. Science literacy was assessed using a questionnaire representing mothers' formal educational attainment and their understanding of applied science concepts relevant to household life, such as knowledge of nutrition, sanitation, and disease prevention. These indicators were selected based on prior research demonstrating a positive association between scientific expertise and family health practices (Ashar, 2022).

Healthy living behavior was measured using a Likert scale encompassing hygienic habits, nutritious dietary patterns, physical activity, and household environmental management, including water, sanitation, and waste management, as these factors have consistently been shown to influence family health (Komro et al., 2011; Qi et al., 2025). Family health status was measured through a combination of mothers' subjective perceptions of their family's health conditions and records of the frequency of illness among family members. This approach has been widely adopted in public health research as it provides a comprehensive overview of actual health conditions (WHO, 2023). All questionnaire items were validated by experts in science education and public health to ensure content relevance and clarity. An initial reliability test was also conducted using the Cronbach's alpha criterion of ≥ 0.70 to indicate acceptable internal consistency. With such a design, the instrument supports the study's validity and allows for replication and comparison with similar studies in different contexts.

Data Collection Procedures

The data was collected systematically to ensure research integrity and replicability. The initial stage involved the development and pilot testing of the instrument, which was based on a review of recent literature and expert input from the fields of science education and public health. The drafted instrument was piloted with 10 mothers with characteristics similar to those of the target population. This number was deemed sufficient to detect issues related to readability and contextual relevance of the items for a small-scale survey study (Kotcher et al., 2021). During the pilot test, participants provided feedback on the clarity of wording and the relevance of the content to daily household life. In addition, two experts in science education and one public health expert evaluated the instrument using the Content Validity Index (CVI). The evaluation resulted in an average CVI score of 0.86, which meets the acceptable content validity threshold (≥ 0.80) as recommended by (Almanasreh et al., 2022). Based on the pilot test and expert validation, several items were revised to simplify the wording, align with respondents' cultural context, and eliminate potential ambiguities.

The next stage was determining participant eligibility criteria to ensure alignment with the focus of the study. Participants were deemed eligible if they: (1) served as mothers responsible for managing family health; (2) had at least one family member living in the same household; (3) were able to read and write; and (4) voluntarily agreed to participate by signing an informed consent form. Those who did not meet these criteria were excluded to avoid data bias and to ensure direct relevance to the study variables (Creswell & Creswell, 2017).

The main stage involved administering the structured questionnaires. Before data collection, the researchers provided a briefing about the study objectives, participants' rights, potential benefits, and procedures for completing the instrument. Informed consent was obtained from all participants, emphasizing that participation was voluntary and they could withdraw without any consequences. After consent was obtained, participants completed the questionnaire independently, with the researcher available to provide technical clarification if needed, without influencing responses. Participant confidentiality was maintained by assigning numeric codes instead of using real names. Each questionnaire was checked for completeness on site to minimize non-responses or missing data.

Data collection was conducted in a single period through face-to-face interactions, following ethical protocols for social and health research. The combination of pilot testing and expert validation, explicit participant eligibility criteria, and transparent data collection procedures ensured the study's scientific accountability and replicability in similar contexts.

Data Analysis

Data analysis in this study was conducted quantitatively using IBM SPSS Statistics version 28 with a significance level set at 0.05. Before hypothesis testing, the researchers first examined the completeness of the questionnaires and coded each response to allow for systematic processing. Incomplete data or responses with potential bias were excluded after reconfirmation with the respective participants. Composite scores for each variable, science literacy, healthy living behavior, and family health status, were calculated based on the mean scores of their respective items. This stage also included a reliability test using Cronbach's alpha to ensure internal consistency, with $\alpha \geq 0.70$ as the threshold for acceptability.

Once the data were verified as valid, descriptive analyses were performed to provide an overview of respondents' profiles and the data's distribution patterns. The descriptive statistics included minimum and maximum values, means, standard deviations, and frequency distributions. These results help readers understand the context of the data before examining inter-variable relationships.

Hypothesis testing was conducted after all parametric analysis assumptions were met. The assumption tests included residual normality using the Shapiro–Wilk test, linearity through the Tests of Linearity in the ANOVA menu, and an examination of homoscedasticity. Multicollinearity was assessed by inspecting the Variance Inflation Factor (VIF) and Tolerance values, while residual independence was examined using the Durbin–Watson statistic. Meeting these assumptions was essential to ensure the validity of inferential results.

The final stage involved analyzing the relationships and contributions among variables. Pearson's correlation coefficient was used to determine the strength and direction of partial relationships between science literacy and healthy living behavior with family health status. Multiple linear regression analysis was performed to test the simultaneous effects with complete reporting of standardized coefficients, p-values, and 95% confidence intervals. In addition to statistical significance, effect sizes such as R^2 and f^2 were calculated to provide practical meaning to the study's findings.

Result and Discussion

To facilitate a rigorous linkage between empirical evidence and interpretation, the present section integrates results with discussion and is structured by the study's guiding research questions: (RQ1) the association between science literacy and family health status; (RQ2) the contribution of healthy living behavior to family health; and (RQ3) the combined influence of science literacy and healthy living within a household-ecology framework. Each subsection first reports the pertinent statistics (descriptive indices, correlation coefficients, and regression parameters) and then advances an analytic commentary that situates the findings within relevant theoretical and empirical literature. A concluding set of subsections synthesizes cross-cutting implications for urban family health, delineates policy and programmatic recommendations, and acknowledges methodological constraints alongside priorities for future inquiry. This organization enables a precise, results-anchored exposition while minimizing redundancy between numerical outcomes and their substantive interpretation.

Association between Science Literacy and Family Health

To address RQ1, the authors situate mothers' science literacy alongside observed family health outcomes and then examine their covariation. Table 2 consolidates central tendency, dispersion, observed ranges, and the Pearson correlation, enabling a direct reading of both absolute levels and the strength of association in everyday household contexts.

Table 2. Descriptive and bivariate results for science literacy and family health (n = 40)

Variable	Mean	SD	Min	Max	r with Family Health
Science literacy	4.10	0.45	3.20	4.90	0.65**
Family health status	4.20	0.40	3.30	4.90	—

** $p < .01$ (two-tailed).

As summarized in Table 2, mothers reported high science literacy (M = 4.10, SD = 0.45) and good family health (M = 4.20, SD = 0.40), with sufficient dispersion to support inference. The association between the two constructs was moderate to strong and positive ($r = 0.65$, $p < .01$), indicating that households with higher literacy levels also tend to report better day-to-day health conditions. Conceptually, this accords with the view of science literacy as a cognitive enabler of evidence-informed action: the capacity to access, interpret, and apply basic scientific concepts, especially in nutrition, sanitation, and infectious-disease prevention, supports healthier domestic ecologies (Nutbeam, 2008). Empirically, the finding converges with prior work showing that higher literacy is linked to stronger adoption of preventive practices and improved outcomes (Walters et al., 2020), more accurate understanding of environment–health pathways relevant to household hygiene (Mishra et al., 2021), and greater engagement with science that predicts protective behaviors during public-health crises (Gu & Feng, 2022). At the same time, the sizeable yet non-deterministic correlation underscores that knowledge is necessary but not sufficient; translation into durable routines likely depends on proximal mechanisms, habit formation and social reinforcement, as well as structural conditions such as time and resource constraints (Paakkari & Okan, 2020). These considerations motivate the subsequent analysis of the direct contribution of healthy living behaviors and, later, their joint effects with literacy within a household-ecology model.

Contribution of Healthy Living Behaviors to Family Health

To address RQ2, the authors report the descriptive level of healthy living behaviors and examine their association with family health, then assess their unique

contribution when modeled alongside science literacy. Table 3 consolidates central tendency, dispersion, observed ranges, the bivariate correlation with family health, and the standardized regression coefficient from the multiple linear model. Presenting these indicators together permits a direct reading of both the magnitude of association and the incremental predictive value of healthy living behaviors in this sample.

Table 3. Descriptive, bivariate, and multivariate results for healthy living behaviors (n = 40)

Variable	M	SD	Min	Max	r with family health	β (multiple regression)
Healthy living behaviors	4.00	0.50	3.10	4.80	.70**	.45**

Model note. Overall model: R^2 = .50; F(2, 37) = 18.45, p < .001. β is standardized and estimated jointly with science literacy (β = .35, p = .007).
Significance note. ** p < .01 (two-tailed).

As summarized in Table 3, healthy living behaviors were, on average, good (*M* = 4.00, *SD* = 0.50) with adequate variation for inference. The bivariate association with family health was strong and positive (*r* = .70, *p* < .01), indicating that households reporting more consistent hygienic routines, balanced diet, physical activity, and household environmental management also report better health conditions. Crucially, when entered simultaneously with science literacy, healthy living behaviors remained a significant predictor (β = .45, *p* = .001) and exerted the larger standardized effect in the model, consistent with the proposition that proximal routines are the most immediate pathway through which knowledge translates into health gains. This is aligned with knowledge-to-action perspectives, which emphasize that information achieves impact only when embedded in daily practice and supported by social context (Graham et al., 2006; Kickbusch et al., 2021). Converging evidence from community and school settings shows that practice-oriented, behaviorally focused interventions, combining education with hands-on skill building, produce more durable improvements than information-only approaches (Komro et al., 2011; Qi et al., 2025; Walters et al., 2020). Taken together, the results underscore that while science literacy provides the cognitive capacity for evidence-informed decisions, healthy living behaviors operate as the proximal mechanism that carries those decisions into everyday household ecologies, an interpretation further examined in the joint model presented next.

Joint Effects within a Household-Ecology Framework

To address RQ3, the authors examined the combined contribution of science literacy and healthy living behaviors to overall family health. This analysis tested whether these two constructs operate synergistically in shaping household health outcomes rather than independently. Table 4 summarizes the multiple regression results, including model fit, standardized coefficients, and explained variance, to clarify their relative and joint effects.

Table 4. Joint model of science literacy and healthy living behaviors predicting family health (n = 40)

Predictor	β (Standardized)	*t*	*p*	95% CI (Lower–Upper)
Science literacy	.35	2.85	.007**	[.10, .60]
Healthy living behaviors	.45	3.65	.001**	[.20, .70]

Model summary. R^2 = .50; *F*(2, 37) = 18.45; *p* < .001.
Note. ** **p** < .01 (two-tailed).

As shown in Table 4, both science literacy (*β* = .35, *p* = .007) and healthy living behaviors (*β* = .45, *p* = .001) made significant independent contributions to family health, and the overall model accounted for 50% of the total variance. This indicates that the two variables jointly explain half of the observed differences in family health outcomes among respondents. Notably, healthy living behaviors exerted the stronger standardized effect, underscoring that behavioral implementation is the proximal driver of health outcomes, whereas literacy provides the cognitive and motivational foundation for these practices to emerge and persist.

This joint influence aligns with the knowledge-to-practice continuum proposed by Kickbusch et al., (2021) and Nutbeam (2008), emphasizing that knowledge acquisition and behavioral application function as interdependent domains rather than sequential stages. Empirical parallels can be found in studies showing that programs integrating scientific understanding with practical training, for instance, sanitation or nutrition workshops, achieve higher retention and behavioral sustainability (Komro et al., 2011; Qi et al., 2025). Moreover, recent findings in global health literacy research (Bo, 2025; Mansour & Alfojery, 2025) highlight that balanced interventions bridging cognitive empowerment and behavioral reinforcement are more effective than approaches emphasizing only one dimension.

In this context, the present findings suggest that empowering mothers through science literacy initiatives must be accompanied by opportunities for habitual enactment of healthful behaviors within their domestic environments. This synergy between knowledge and practice is particularly vital in urban Indonesia, where access to information is high but its translation into consistent action remains uneven. Thus, the integrated

model underscores the importance of designing dual-focus interventions that combine conceptual literacy with behavioral reinforcement to optimize family health outcomes.

Implications, Limitations, and Future Research

The findings indicate that science literacy and healthy living behaviors act as mutually reinforcing determinants of family health. Science literacy provides the cognitive scaffolding to appraise risk and interpret evidence, while routine practices constitute the proximal mechanism through which evidence-informed judgments are enacted in daily life, an interdependence consistent with health-literacy theory and governance perspectives that emphasize moving from knowledge to action in real contexts (Kickbusch et al., 2021; Nutbeam, 2008). Empirically, the pattern also aligns with reviews showing that literacy gains are associated with improvements in health behaviors and outcomes, but that knowledge alone rarely sustains change without attention to enactment and context (Walters et al., 2020) . Policy and practice should therefore privilege dual-focus designs that integrate conceptual understanding with behavior-enabling supports.

Actionable implications follow directly. First, pair non-formal science education with practice laboratories, brief, neighborhood-based sessions on hand hygiene, safe water storage, menu planning with locally available foods, and household waste management, each closing with one auditable habit to adopt in the following week. Second, embed behavioral scaffolds that make healthy choices salient and easy (checklists at sinks, refrigerator cue cards for portions, SMS prompts synced to mealtimes, caregiver "buddy" pairings) to translate literacy into routine, consistent with evidence that practice-oriented, community interventions outperform information-only approaches (Komro et al., 2011; Walters et al., 2020). Third, create micro-partnerships among community health posts, schools, and local organizations (e.g., a monthly "Healthy Household Hour" combining growth monitoring, sanitation demonstrations, and Q&A), monitored with compact dashboards (participation, habit adoption, two–three sentinel outcomes) and periodic feedback, an approach consonant with governance frameworks for equitable health futures (Kickbusch et al., 2021) and with WHO guidance on addressing social determinants (WHO, 2023).

Several constraints temper inference. The design is cross-sectional and correlational, limiting causal claims; the urban, modest sample constrains generalizability; and outcomes are self-reported, risking recall and social desirability bias. To mitigate these in implementation, combine brief surveys with lightweight objective indicators, spot checks of handwashing stations, photo logs of meals, simple water test strips, verification of clinic visits, so routine monitoring does not rely solely on self-report (cf. Walters et al., 2020). Stratifying dashboards by time availability, income, and caregiving load can surface heterogeneous effects and guide adaptive supports for groups least likely to benefit under standard delivery, in line with social-determinant perspectives (WO, 2023).

Future researches should shift from association to tested implementation. Priorities include longitudinal or cluster-randomized trials comparing education-only arms to integrated literacy-plus-practice arms, with preregistered outcomes, effect sizes, and cost-per-improved-household metrics (Walters et al., 2020). Mixed-methods process evaluations can map how literacy becomes habit (or fails to) within specific household ecologies, while mediation/moderation analyses can estimate the roles of social support and access to services (Kickbusch et al., 2021; Nutbeam, 2008). Finally, scaling studies should compare delivery channels (health posts vs. schools vs. digital nudges) and report equity-sensitive impacts, aligning evaluation with global calls for integrated, context-aware health governance (Kickbusch et al., 2021; Organization, 2023).

Conclusion

This study demonstrates that science literacy and healthy living behaviors are interdependent factors shaping family health, particularly in urban communities, with healthy living exerting a somewhat stronger influence. Beyond confirming this empirical link, the study contributes theoretically by connecting knowledge and practice within a household ecology framework, emphasizing that scientific understanding achieves impact only when embodied in daily routines. However, as a cross-sectional, non-experimental study based on self-reported data and a relatively small urban sample, causal interpretation and generalization remain limited. Future research should employ longitudinal or experimental designs, incorporate objective and environmental indicators, and include more diverse populations to test mediation and moderation effects—such as whether healthy living mediates the influence of science literacy, or whether socio-economic and social support factors moderate these relationships. Scientifically, the findings advance discussions on how literacy translates into behavior within real household ecologies, while practically, they advocate for community programs that merge science education with habit-forming health initiatives to achieve more sustainable and equitable public health outcomes.

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Author Contributions
Conceptualization, Ichwan and Mudayat; methodology, Ichwan; software, Ichwan; validation, Ichwan and Mudayat; formal analysis, Ichwan; investigation, Ichwan; resources, Mudayat; data curation, Ichwan; writing—original draft preparation, Ichwan; writing—review and editing, Mudayat; visualization, Ichwan; supervision, Mudayat; project administration, Mudayat; funding acquisition, Mudayat. All authors have read and approved the final version of the manuscript for publication.

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