QCU The STAR: Journal of Science, Engineering, and Information Technology
Vol. 2, No. 1, November-December 2024

Future-Ready Learning Through Clean Practices and Green Behavior: Linking Education, Waste Management, and Health Goals

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Abstract. This study examines the integration of waste management, green behavior, and hygiene practices in educational settings to support Sustainable Development Goal 3 (SDG 3) and promote future-ready education. The primary aim is to understand how these sustainable practices, underpinned by green behavior, can improve health outcomes and educational preparedness for future generations. This research uses a systematic literature review approach to analyze existing literature on waste management, green behavior, clean practices, and health in academic environments. Findings reveal a strong correlation between implementing sustainable waste management practices and improved student well-being and learning environments. The review also highlights critical gaps in current educational policies and suggests comprehensive approaches to embedding green behavior and clean practices into the curriculum. This research recommends an interdisciplinary approach for policymakers and educators to drive educational health and sustainability goals. The study concludes by proposing further research into specific clean practices, green behavior, and waste management systems suitable for diverse educational settings to support global health initiatives.

Keywords: *Future-ready education; sustainable practices; green behavior; waste management; SDG 3.*

INTRODUCTION

In the context of global efforts to address sustainability challenges, educational institutions have emerged as critical platforms for cultivating environmental responsibility and sustainable practices. However, many schools and universities still face challenges in systematically integrating sustainability principles into their curricula. The increasing prevalence of waste mismanagement, coupled with a lack of structured hygiene practices, poses risks to both student health and environmental well-being. These issues underscore the need for innovative approaches to equip students with future-ready skills while fostering a commitment to sustainable development goals, particularly SDG 3—good health and well-being.

For instance, Vintere (2020) emphasizes that education is a transformative tool necessary for resolving social, economic, and environmental issues, advocating for the reorientation of educational practices towards Education for Sustainable Development (ESD) at all levels. This is echoed by Painter-Morland et al. (2016) who highlight the need for innovative curricula and alternative delivery modes to advance sustainability agendas within business schools, indicating that leadership and faculty alignment is crucial for effective integration. El-Hamed et al. (2022) discuss how educational systems must address sustainability challenges to ensure a secure and productive future, particularly in nursing education, which is vital for promoting health and well-being. Furthermore, the integration of sustainability into curricula across Europe is uneven, suggesting that localized approaches may enhance the effectiveness of sustainability education (Karmasin & Voci, 2021). This inconsistency in curriculum integration underscores the urgent need for innovative strategies that not only address waste management but also promote overall health and well-being, aligning with Sustainable Development Goal 3 (SDG 3).

This study seeks to explore how clean practices and green behavior, particularly in the context of waste management, can be effectively integrated into educational systems to promote health, sustainability, and future readiness. By examining the role of waste management and clean practices in enhancing student health outcomes, this research highlights the potential of education as a vehicle for achieving both immediate health goals and long-term environmental sustainability.

The integration of sustainable practices into educational systems has gained prominence in recent years, as schools and universities are increasingly recognized as crucial spaces for fostering environmental responsibility and preparing students for a sustainable future. Research highlights the multifaceted benefits of implementing clean practices, such as waste management and hygiene protocols, in educational settings. These benefits range from improved student health and engagement to the cultivation of green behavior that extends beyond the classroom.

Studies focusing on waste management in higher education suggest that structured waste reduction programs, recycling initiatives, and composting not only reduce environmental impact but also enhance students' understanding of sustainability principles. For instance, initiatives that involve students directly in waste audits or recycling programs have been found to improve their ecological literacy and encourage lifelong habits of resource conservation. However, while such interventions have shown promise, their implementation often varies significantly across institutions, leading to inconsistent outcomes.

The relationship between clean practices and health goals has also been well-documented in the literature. Hygiene practices, such as regular handwashing and maintaining clean school environments, are critical to

preventing the spread of diseases, especially in primary and secondary schools. Schools that integrate health-focused policies with environmental initiatives, such as eco-friendly cleaning products and proper waste disposal systems, report better health outcomes among students and staff. Yet, gaps persist in linking these practices to broader educational frameworks, leaving room for improvement in aligning health goals with sustainability efforts.

Additionally, fostering green behavior within education systems is pivotal for achieving SDG 3 (good health and well-being) and other sustainability targets. Green behavior involves cultivating attitudes and actions that prioritize environmental stewardship, such as reducing waste, conserving energy, and supporting community-based sustainability projects. Research shows that early exposure to sustainability concepts in school curricula correlates with higher levels of environmental responsibility in adulthood. However, many existing studies fail to explore the long-term impact of such initiatives or how they can be systematically embedded into educational policies.

Despite these advancements, a noticeable gap exists in studies that connect the dots between education, waste management, health goals, and green behavior. Much of the literature focuses on one dimension—such as waste management or health—without examining their interconnectedness. This fragmented approach limits the potential for comprehensive strategies that leverage education as a driver for sustainability.

This study addresses this research gap by synthesizing existing literature to identify effective strategies for embedding clean practices and green behavior into educational curricula. By focusing on the intersection of education, waste management, and health goals, this research aims to bridge the divide between theory and practice, offering actionable insights for educators and policymakers.

In addressing these issues, this study proposes the following research questions:

1. How do waste management and clean practices in educational settings influence students' health and well-being?
2. In what ways can green behavior and sustainability principles be effectively integrated into school curricula to support future-ready education?

METHODOLOGY

This study employed a Systematic Literature Review (SLR) to analyze relevant literature on future-ready learning through clean practices and green behavior, focusing on waste management, higher education, and Sustainable Development Goal 3 (SDG 3). Systematic reviews utilize explicit, structured steps, rather than heuristics, to conduct thorough searches and critical assessments of the literature (Crossan & Apaydin, 2010). By employing transparent and reproducible procedures, systematic reviews enhance the quality of both the review process and the results (Tranfield et al., 2003; Zhang et al., 2022). The specific steps undertaken in this study included the development of search syntax and inclusion criteria, study selection, and the subsequent analysis and synthesis of findings. The search was limited to articles published between 2015 and 2024 to ensure the inclusion of recent and relevant studies. The research utilized the Publish or Perish application to search for articles indexed in Scopus using the keywords waste management, SDG 3, and higher education. The initial search retrieved 421 articles from Scopus.

In the identification phase, duplicate entries were removed, reducing the dataset by 191 articles, and leaving 230 unique records. Subsequently, 28 articles were excluded because they were written in languages other than English. Additionally, 32 articles were excluded for other reasons, such as irrelevance or inaccessible files. After this phase, 170 articles remained for further screening.

During the screening process, 14 articles categorized as books, conference papers, or proceedings were excluded, resulting in 156 articles. Of these, 39 articles were eliminated due to inaccessibility, leaving 117 articles for full-text review. Further assessment led to the exclusion of 28 articles because of incomplete data, such as missing abstracts or key information. An additional

47 articles were removed because their topics were not aligned with the research objectives. Ultimately, 42 articles were deemed eligible and included in the final analysis.

The selection process followed the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) framework to ensure a systematic and transparent review. The PRISMA flow diagram illustrates the stages of identification, screening, eligibility assessment, and inclusion, detailing the refinement from an initial pool of 421 articles to the final 42 studies included in the review (Figure 1). This rigorous process ensures that only high-quality, relevant literature is considered, providing a strong foundation for analyzing the relationships between education, waste management, health goals, and green behavior.

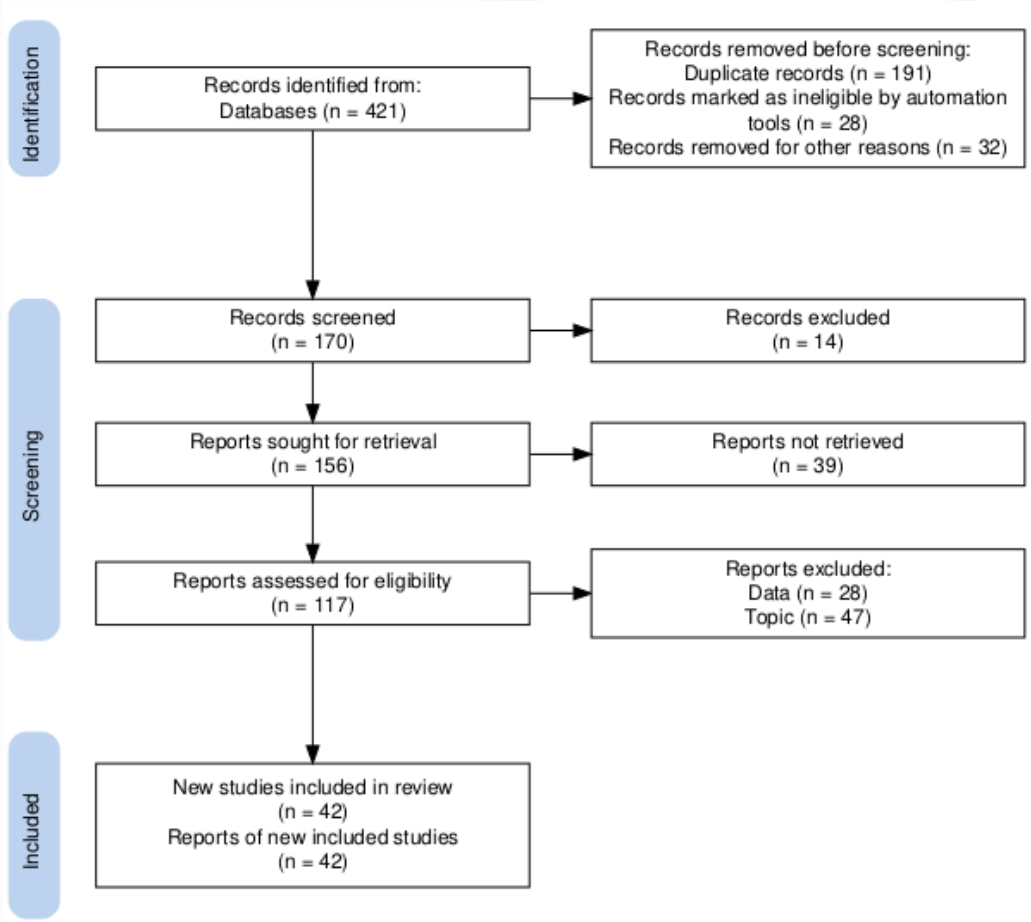

Figure 1. PRISMA flow diagram

RESULTS

Publication Years

Based on Figure 2. the publication data from the years 2015 to 2024 shows a gradual increase in the number of studies related to the topic, reflecting a growing interest in the field over time. In 2015, there were only 2 publications, which was a relatively low number compared to later years. The following years, 2016 and 2017, saw a slight increase, each with 3 publications, maintaining a steady but modest pace of research output. In 2018, the number dropped to just 1 publication, potentially reflecting a lull in the research focus during that period.

However, from 2019 onwards, there was a noticeable increase in publications. The number of publications rose to 2 in 2019, and in 2020, it grew again to 3 publications, signaling a consistent, though still moderate, growth in interest. The trend began to accelerate significantly in 2021, with 5 publications, followed by a sharp increase to 7 publications in 2022. This upward trend continued into 2023, which saw the highest number of publications in the dataset, with 9 publications, reflecting a peak in research activity.

The number of publications slightly decreased in 2024 to 7. Yet, it remains high compared to the earlier years, indicating that the topic continues to be an area of active research and development, particularly in sustainability, waste management, and education. Overall, the data highlights a steady and sustained growth in the research output on this topic over the last decade, suggesting that issues related to waste management, clean practices, and sustainability have become increasingly central in academic discourse, particularly in the last five years.

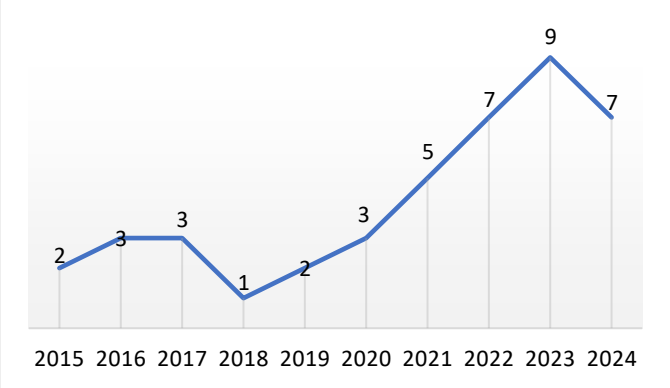

Figure 2. Publication Years

Country of Study

Figure 3 shows the distribution of publications by country and highlights the global focus on research related to waste management, clean practices, and sustainability, with notable contributions from both developed and developing nations. Malaysia leads with the highest number of publications (6), showcasing its significant involvement in advancing sustainable practices and environmental management within educational contexts. Following closely, Brazil and China each have 4 publications, strongly emphasizing sustainability initiatives in these regions, particularly within higher education institutions.

Japan and Thailand contribute substantially as well, with 3 publications each, indicating their commitment to integrating green practices and sustainability principles into various sectors, including education. Countries such as India, Indonesia, Italy, South Africa, Romania, and the USA each have 2 publications, suggesting a moderate level of engagement with the topic.

Other countries, including Bahrain, Bangladesh, Bolivia, Colombia, England, Ghana, Jordan, Portugal, Russia, and Spain, each have 1 publication. This shows that while these nations have contributed to the discourse, their focus on the subject may be emerging or more specialized. Overall, the data indicates that the topic of sustainable practices and waste management in education has garnered widespread attention across continents, with some countries taking a leading role in advancing research and others beginning to explore these critical issues. This geographic diversity underscores the universal relevance of sustainability in addressing global challenges.

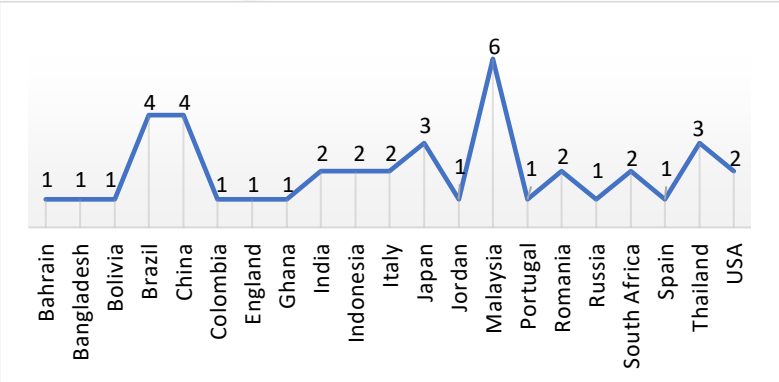

Figure 3 Country of Publication

Table 1.

Review of Key Finding

No	Author, Year	Key Finding	Country
1	Phrophayak et al. (2024)	Effective waste management at Mahasarakham University led to continuous progress in sustainability, guided by five key strategies: adopting green university policies, integrating 3R principles, allocating budgets based on evaluations, encouraging participation through committees, and using the PDCA process for monitoring. These efforts supported the university's sustainable development goals and its transition to a green university.	Thailand
2	Yusuf & Fajri (2022)	The educational environment plays a crucial role in enhancing students' knowledge, behavior, and engagement in waste	Indonesia

		management. At Syiah Kuala University, students demonstrate strong environmental attitudes, supported by campus policies and programs. Notably, social science students excel in environmental behavior, while science students show higher levels of engagement and knowledge. Environmental conservation programs and policies significantly promote sustainable development and waste-free practices. Institutions are encouraged to adopt comprehensive environmental education initiatives to foster these outcomes.	
3	Alalawi & Omar (2024)	Buildings and transportation significantly contribute to energy-related emissions, with Bahrain's greenhouse gas emissions rising from 16 Mt/year in 1990 to 54 Mt/year in 2020. This research examines the factors influencing pro-environmental behavior at the University of Bahrain and underscores the role of higher education in promoting sustainability through strategic frameworks and green initiatives. The findings offer valuable insights for stakeholders and policymakers in advancing zero-emissions goals.	Bahrain
4	Roy (2023)	Students' intentions to reuse cups are influenced by moral norms and behavioral control, with green university initiatives playing a key role in shaping these factors. Environmental values further enhance the connection between norms and intentions. The findings offer guidance for policymakers to foster green behavior and sustainable practices, such as using reusable drinkware.	Bangladesh
5	Gherheș et al. (2024)	Over 50% of students reuse recyclables, but only 25% separate waste, indicating a need for stronger interventions. Achieving sustainability requires collaboration among universities, local authorities, waste companies, and students, supporting strategies aligned with SDG 17 to enhance territorial sustainability.	Romania
6	Ribeiro et al. (2021)	Green Campus Initiatives at four Brazilian universities boost students' sustainability knowledge, awareness, and proactivity, with	Brazil

		dissemination strategies influencing 27.7% of knowledge and 18% of proactivity. The findings highlight the role of student engagement in fostering sustainable practices in higher education.	
7	Agarwal (2023)	Sustainability initiatives at Delhi University colleges, categorized as Go-Brown, Go-Green, and Smart, aim to enhance environmental awareness and infrastructure. The study introduces the "Educational Institutional Environmental Sustainability Stars" framework to evaluate practices across water, waste, air, land, and energy parameters. Findings emphasize the potential of such initiatives, supported by government policies, to create smart, sustainable universities, despite limitations in generalizability and student engagement impact.	India
8	Lee & Lee (2022)	This study estimates the cost of emissions from campus waste to highlight the benefits of internal carbon pricing in advancing campus carbon neutrality efforts. It explores how carbon pricing can reduce emissions through improved waste management, offering practical insights for enhancing sustainability in university settings.	USA
9	Baba-Nalikant et al. (2023)	The study across three Malaysian universities found that knowledge, attitudes, and values strongly influence zero-waste, pro-environmental behavior on campus, with technology playing a supportive role. It highlights that knowledge and attitudes act as key factors in promoting sustainable practices, suggesting that integrating these elements into a zero-waste campus framework can help universities develop targeted strategies for fostering pro-environmental behavior.	Malaysia
10	Manomaivibool et al. (2016)	Voluntary behavior changes are limited to actions with minimal effort. To further prevent food waste, interventions such as rule-based measures, economic incentives, and changes in food service settings should be considered. Additionally, options for reusing	Thailand

		and recycling fluid and other unavoidable food waste are necessary.	
11	Chan et al. (2022)	A Malaysian public university has been promoting environmental protection and sustainable waste practices since its 2008 ban on polystyrene containers, known as the "White Coffin" initiative. This initiative laid the groundwork for ongoing sustainability efforts, including the "Kampus Sejahtera" program, sustainability courses, and events like sustainability month. Ranked 39th globally in the Times Higher Education University Impact Rankings 2021, the university emphasizes collaboration with local NGOs, industries, and academia to drive sustainability, particularly during the COVID-19 pandemic. This case study showcases the university's leadership in advancing environmental practices in higher education.	Malaysia
12	Zhao & Zou (2015)	Tsinghua University's green initiative is part of its strategy to become a world-class institution and promote a sustainable society. The initiative is built around one core principle—green university—and three dimensions: green education, green research, and a green campus. While the initiative has achieved significant success, it has also faced challenges, including neglecting social justice, fragmented coordination, and a lack of effective communication and assessment mechanisms.	China
13	Aregarot et al. (2024)	The GU SI, with 27 indicators across seven aspects, is a simple and relevant tool to assess university sustainability in Thailand. It showed high scores in the studied universities but is limited to Thai institutions.	Thailand
14	Owojori et al. (2022)	Students have low knowledge of waste management but are willing to participate in recycling. Economic incentives and better environmental education are needed to improve participation and transition to a circular economy.	South Africa
15	Budihardjo et al. (2021)	At UNDIP, factors like student awareness, gender ratio, staff background, and green space contribute 67.7% to waste generation,	Indonesia

		with awareness being the most significant. Environmental education can help reduce waste in higher education institutions.	
16	Vikram & Tiwari (2024)	Higher education institutions play a key role in promoting sustainability through green practices, campus development, and attracting global students. Educators are essential in advancing sustainability goals aligned with the 2030 Agenda.	India
17	Barros et al. (2020)	Universities are adopting sustainable practices, such as replacing plastic cups with reusable ones to reduce waste. However, this increased water consumption, prompting efforts to reduce water use. The study highlights the need for universities to carefully assess the impact of their green initiatives.	Brazil
18	Abakumov & Beresten (2023)	The results of the work indicate the most effective methods of forming a “green” image of the university and create a system of indicators based on the questionnaire of the rating “University of Indonesia (UI) Green Metric World University Ranking”.	Russia
19	McGibbon & Van Belle (2015)	Integrating Green IS into the curriculum provides opportunities for students to engage in carbon footprinting and sustainable campus operations. However, despite the impact of monitoring emissions and involving students, these actions alone do not lead to reduced emissions, highlighting the need for more robust strategies.	South Africa
20	Gallardo et al. (2016)	The waste generation and composition at Universitat Jaume I over a school year, identifying and quantifying various waste streams, especially those not currently controlled. Statistical analyses revealed that waste generation varies by season and day of the week. The findings provide valuable insights that can help university authorities implement targeted waste minimization measures and enhance existing waste management practices.	Spain
21	Ottoni et al. (2022)	Only 17% of Brazilian public universities have a Waste Management Plan (WMP), and most are limited to healthcare waste. These plans lack specific deadlines and long-term goals,	Brazil

		addressing waste management reactively rather than proactively.	
22	Zen et al. (2016)	Waste minimization efforts, like paper-saving and recycling, have led to reduced environmental impact and financial savings. The Green Office initiative, which involves campus-wide collaboration, serves as a model for integrating sustainability into university operations, showing the benefits of decentralizing waste management and involving all stakeholders.	Malaysia
23	Colding & Barthel (2017)	University campuses have significant potential to drive global sustainability by fostering sustainable practices, biodiversity, and ecosystem services. They play a key role in promoting socio-cultural transitions that address climate change and biodiversity loss. This research highlights the importance of designing resilient campuses as ecosystems and provides policy recommendations for higher education institutions to accelerate sustainable biosphere management, reinforcing their role as Earth System stewards.	USA
24	Mahat et al. (2017)	Sustainable consumption practices effectively educate younger generations on sustainability. The study finds that while ESD knowledge differs between genders, sustainable consumption practices are similar. However, urban students show better implementation than rural students, despite similar ESD knowledge. These findings emphasize the need for broader collaboration across schools, communities, government, and NGOs to promote more equitable and impactful sustainability practices.	Malaysia
25	Cleverdon et al. (2017)	The study on the University of Northampton's "Planet Too" project found that while student awareness of sustainability increased, practical changes like recycling were more noticeable than long-term conservation shifts. Landlords focused on energy and water conservation, but these behaviors remained static. Ongoing efforts and recommendations are necessary to strengthen the impact and	England

		longevity of sustainability initiatives in higher education.	
26	Fissi et al. (2021)	The University of Florence's sustainability strategies include green buildings, waste management, and sustainable mobility despite financial constraints. While sustainability is prevalent in educational programs and research, coordination between these areas is lacking. Strong leadership supports the university's progress, though more community engagement and external accountability are needed for a fully integrated sustainability approach.	Italy
27	Pan et al. (2022)	At East China Normal University, student behavior significantly influences domestic solid waste generation. Waste generation averages 0.275 kg per day, with attitudes towards waste playing a key role in reduction. The study suggests tailored policies, environmental education, and cultural activities to improve waste management on campus.	China
28	Abu Qdais et al. (2019)	JUST University, located in a semiarid region, demonstrates sustainability through low carbon emissions (1.33 tons CO2e per capita) and water consumption (56 L per day). Solid waste generation is also lower than in other global institutions, making it a model for sustainability practices in water-scarce regions.	Jordan
29	Ferronato et al. (2020)	A Bolivian university's recyclable waste selective collection (SC) system showed significant improvements in waste management, with 15 kg of plastic and 37.1 kg of paper collected monthly. Student awareness and satisfaction with the system increased significantly, providing a replicable framework for similar initiatives in developing countries aligned with circular economy principles.	Bolivia
30	Muhiddin et al. (2023)	Malaysian public universities are committed to green initiatives to address environmental challenges. Despite facing structural, financial, and logistical issues, solutions exist through strong collaboration between university management and the campus	Malaysia

		community. Aligning green efforts with the Sustainable Development Goals is key to ensuring a sustainable future for these campuses.	
31	Barreiros et al. (2023)	Institutions have implemented water efficiency measures with consumption ranging from 1.8 to 23.5 L per person per day. Differences are linked to campus characteristics such as green areas, water sources, and facilities. Sharing this data among institutions could improve water efficiency, especially amid growing water scarcity concerns.	Portugal
32	Osorio et al. (2022)	Universidad Pontificia Bolivariana and Universidad Ean became the first carbon-neutral universities in Latin America and Colombia, respectively. These universities show that higher education institutions (HEIs) can play a significant role in regional and global sustainability by achieving carbon neutrality and promoting sustainability culture through education.	Colombia
33	Asefi et al. (2024)	In China, food waste awareness varies by education level and gender, with significant differences in shopping habits and food waste management methods. Increased awareness through education and media encourages participation in reducing food waste, highlighting the need for targeted training on waste management for students.	China
34	da Silva et al. (2023)	Variations in carbon footprint (CF) calculations among HEIs stem from differing metrics, data collection, and emission sources, especially Scope 3 emissions. Despite inconsistencies, there is a push for standardization, and HEIs are making efforts to decarbonize campuses. Solutions are needed for standardized, global CF measurements and methodologies.	Brazil
35	Salifu et al. (2024)	In Ghana, students' green consumption behavior is influenced by campus sustainability (CNS) and environmental clubs (ECs), with females responding more strongly to CNS. Gender moderates the relationship, and a lack of social influence	Ghana

		and behavioral control was found to have minimal impact.	
36	Boca & Saraçli (2023)	Students at a university showed awareness of biodegradable plastics but acted based on the situation. Female students were more attentive to selecting bioplastic, while male students were more involved in nature cleaning. Awareness of plastic waste significantly influenced their behavior, suggesting universities can use education and volunteering to promote bioplastics.	Romania
37	Isa et al. (2021)	UiTM Perak's green campus initiative faces challenges such as financial limitations and low awareness. However, the management has outlined actions to overcome these obstacles, emphasizing the need for support from all parties for successful sustainability implementation.	Malaysia
38	Genta et al. (2019)	A 21% reduction in the ecological footprint (EF) of universities can be achieved through green campus projects. These initiatives improve sustainability while demonstrating how the built environment can benefit both the environment and occupants.	Italy
39	Qu et al. (2023)	College students' waste separation behaviors are influenced by attitudes, especially knowledge, and by contextual factors such as year of study. Freshmen showed more positive behaviors, and external factors moderated the impact of attitudes, providing insights for optimizing campus waste management systems.	China
40	Uehara & Ynacay-Nye (2018)	Students at a university showed willingness to pay for a waste recycling system (WRS), with potential savings of over 45,000 plastic bottles and reduced CO2 emissions annually. The study highlights the importance of information campaigns to encourage pro-environmental behavior.	Japan
41	Makino et al. (2021)	Using pruned branches for heating on campus reduces greenhouse gas emissions more effectively than current power systems. The proposed heating system offers higher efficiency and a short payback period, reducing cumulative costs by approximately 20% over 20 years.	Japan

42	Ikegami & Neuts (2020)	Cluster analysis identified four types of institutions based on sustainability strategies: "lagging-behind", "asset-driven", "top-of-the-class", and "networkers". Both large and small institutions can achieve sustainability goals by adopting holistic strategies or focusing on asset management and networking.	Japan

Analysis of Key Findings

Waste Management and Clean Practices in Educational Settings' Influence on Students' Health and Well-Being

The articles reviewed provide comprehensive insights into the significant influence of waste management and sustainability practices on students' health and well-being. The findings highlight the multifaceted impact of these practices, emphasizing how environmental education plays a crucial role in shaping students' attitudes and behaviors toward waste management and sustainability. For instance, Yusuf and Fajri (2022) underscore the importance of university policies in cultivating positive environmental attitudes among students, which leads to increased participation in sustainability initiatives. Similarly, Baba-Nalikant et al. (2023) found that knowledge and attitudes are pivotal in fostering pro-environmental behaviors on campuses, suggesting that enhanced awareness is a key factor in the adoption of sustainable practices.

Effective waste management practices in educational institutions play a pivotal role in fostering healthier campus environments and promoting students' health and well-being. At Mahasarakham University, the implementation of 3R principles (Reduce, Reuse, Recycle) and PDCA processes enhance sustainability while creating a cleaner campus, directly benefiting students' health (Phrophayak et al., 2024). Similarly, East China Normal University highlights the role of student behavior in reducing solid

waste, which improves campus cleanliness and health outcomes (Pan et al., 2022). At Universitat Jaume I, targeted waste minimization efforts effectively reduce unmanaged waste, supporting a healthier and more sustainable campus environment (Gallardo et al., 2016). JUST University exemplifies sustainable practices with low waste generation and water consumption, especially crucial in a water-scarce region, ensuring a safe and health-conscious setting for students (Abu Qdais et al., 2019). Despite challenges, UiTM Perak addresses waste management and green initiatives by raising awareness and improving the overall campus environment, indirectly contributing to student well-being (Isa et al., 2021). Furthermore, the work of Dongxu Qu (2023) underscores the importance of enhanced waste separation behaviors and effective management systems, which reduce pollution and improve campus cleanliness, positively impacting students' health. Lastly, Zen et al. (2016) demonstrate the success of decentralized waste management through the Green Office initiative, which delivers both financial and environmental benefits while fostering a healthier campus ecosystem. Collectively, these cases illustrate how strategic waste management and clean practices in educational settings enhance student health and well-being.

Effective waste management and environmental education play a crucial role in promoting students' health and well-being by fostering cleaner and more sustainable campus environments. Owojori et al. (2022) emphasize the importance of improving students' knowledge of waste management through enhanced environmental education and economic incentives, which encourage recycling participation and contribute to a healthier campus. Barros et al. (2020) demonstrate that replacing disposable materials with sustainable alternatives, such as reusable cups, significantly reduces waste and enhances campus cleanliness, though it necessitates managing the associated increase in water usage. Similarly, Barreiros et al. (2023) highlight the impact of water efficiency measures in reducing waste and addressing

water scarcity, thereby supporting sustainability and ensuring a safer campus environment. Boca et al. (2023) further illustrate how heightened awareness of biodegradable plastics and student involvement in environmental cleanups strengthen waste management practices, creating cleaner spaces that promote overall well-being. Collectively, these studies underscore the interconnectedness of effective waste management practices and their positive influence on student health and campus sustainability.

Several studies also establish a direct connection between clean practices, waste reduction, and improved student health outcomes. Ribeiro et al. (2021) demonstrated that university initiatives in Brazil that focused on recycling and waste segregation significantly boosted student knowledge and proactivity, contributing to a cleaner and healthier campus environment. Furthermore, Manomaivibool et al. (2016) highlighted the positive effects of reducing food waste, noting that sustainability measures not only alleviate environmental burdens but also contribute to students' physical well-being by reducing food-related waste on campuses, thus promoting a healthier environment.

In addition to physical health, some studies emphasize the psychological benefits of waste management initiatives, including increased social engagement and a heightened sense of purpose among students. McGibbon and Van Belle (2015) explored how the integration of green initiatives into university curricula not only raised awareness about sustainability but also encouraged students to actively engage in sustainable campus operations. This engagement fostered a positive and environmentally conscious student body, further enhancing their mental well-being. Moreover, clean campus initiatives, such as waste segregation and energy-efficient practices, are shown to have a broader impact on physical health by reducing pollution and mitigating waste-related health risks. Chan et al. (2022) discuss how these sustainable practices contribute to creating a healthier campus environment

by lowering exposure to harmful pollutants and fostering active, outdoor lifestyles, which in turn promote better physical health for students.

Integrating Green Behavior and Sustainability Principles into School Curricula for Future-Ready Education

In addition to waste management practices, many of the reviewed articles emphasize the importance of integrating green behavior and sustainability principles into school curricula as a means of fostering future-ready education. Several studies underscore the necessity of embedding sustainability into educational frameworks to ensure that students are equipped with the knowledge and skills required to address global environmental challenges. Lee and Lee (2022), along with Aregarot et al. (2024), advocate for the adoption of green campus policies, such as carbon pricing and sustainability-focused curricula, which can transform educational environments and prepare students to engage with pressing global sustainability issues effectively.

Integrating green behavior and sustainability principles into school curricula is essential for cultivating future-ready education and fostering global citizenship. Roy (2023) highlights how green university initiatives, anchored in moral norms and environmental values, promote sustainable practices like reusable drinkware, offering pathways for curriculum integration. Similarly, Delhi University's "Educational Institutional Environmental Sustainability Stars" framework evaluates sustainability practices, serving as a model for embedding these principles in educational settings (Agarwal, 2023). The University of Bahrain exemplifies this approach by fostering pro-environmental behavior through strategic frameworks that align institutional goals with sustainability values (Alalawi & Omar, 2024). Campuses, as hubs of innovation, also play a crucial role in addressing global challenges. Colding and Barthel (2017) emphasize their potential to foster biodiversity and socio-cultural transitions through sustainability-focused education. Vikram and

Tiwari (2024) further underscore the alignment of higher education curricula with the 2030 Agenda, preparing students for leadership in sustainability and global citizenship. Mahat et al. (2017) advocate for sustainable consumption practices and emphasize the importance of collaboration between schools and communities to advance equitable sustainability education. At the same time, Budihardjo et al. (2021) reveal that increased student awareness and environmental education significantly reduce waste and enhance readiness for future sustainability challenges. Salifu et al. (2024) highlight the role of environmental clubs and campus sustainability initiatives in fostering experiential learning, aligning with curriculum goals. Asefi (2024) demonstrates how targeted campaigns on food waste management can effectively integrate sustainability practices into educational environments. Finally, Ikegami (2020) categorizes holistic sustainability strategies based on institutional capabilities, providing valuable insights into embedding green behavior and sustainability principles across diverse educational frameworks. Together, these studies illustrate a multifaceted approach to integrating sustainability into curricula, equipping students with the knowledge and values to address future challenges.

Integrating sustainability principles into higher education frameworks is essential for fostering future-ready education and promoting green behavior. Abakumov and Beresten (2023) propose a structured model using indicators to create a "green" university image, providing a roadmap for embedding sustainability into institutional practices. Cleverdon et al. (2017) illustrate the impact of projects like “Planet Too,” which align curricula with sustainability principles and increase student awareness, although practical actions like recycling show more measurable progress. Muhiddin et al. (2023) underscore the importance of aligning green initiatives with the Sustainable Development Goals (SDGs), ensuring these principles become integral to educational practices. Osorio et al. (2022) demonstrate how achieving carbon neutrality positions universities as regional leaders in sustainability culture, influencing

broader educational systems. Similarly, da Silva et al. (2023) highlight the need for standardized carbon footprint metrics, enabling institutions to embed sustainability monitoring and education more effectively. Genta (2019) emphasizes the dual benefits of green campus projects, reducing ecological footprints while educating students on the relationship between the built environment and sustainability. Uehara (2018) showcases the role of waste recycling systems and student engagement campaigns in promoting green behavior and sustainability awareness. Makino (2021) highlights innovative practices like using pruned branches for campus heating, exemplifying how practical applications of sustainability can be integrated into educational settings to inspire future leaders in environmental stewardship. Together, these initiatives demonstrate the transformative potential of integrating sustainability into higher education.

Students' engagement is also highlighted as a critical factor in enhancing sustainability knowledge and fostering a future-ready education. Gherheș et al. (2024) and Boca and Saraçli (2023) emphasize that aligning academic curricula with practical sustainability initiatives can significantly contribute to students' understanding and participation in sustainability efforts. By actively involving students in green behavior, such as recycling and waste reduction, these programs promote a deeper sense of responsibility and involvement, equipping students to contribute meaningfully to sustainability goals both during and after their studies.

The impact of behavioral influence and social learning through sustainability initiatives is another key theme discussed in the literature. Zhao and Zou (2015) explored how green university initiatives at Tsinghua University facilitated not just knowledge acquisition but also active participation in sustainability activities across campus. This model of learning, which involves students in hands-on sustainability practices, encourages a culture of environmental stewardship. Similarly, Fissi et al. (2021) stress that strong

leadership and policy frameworks within universities are essential for achieving sustainability goals, which, in turn, enhances students' preparedness for careers in green industries by offering them relevant, real-world skills.

Moreover, several articles argue that curriculum integration should not be limited to theoretical knowledge but should also include practical, hands-on experiences that address real-world sustainability challenges. Ferronato et al. (2020) and Ottoni et al. (2022) advocate for the inclusion of sustainability issues in curricula through experiential learning, such as engaging students in waste reduction, recycling, and carbon neutrality initiatives. These initiatives help students apply sustainability principles outside of the classroom, providing them with valuable skills and fostering a deeper connection to environmental issues.

Finally, the long-term impact of sustainability programs in educational settings is also a topic of discussion. Fissi et al. (2021) argue that for sustainability integration to have a lasting impact, universities must prioritize continuous improvements in infrastructure, engagement, and measurable outcomes. They advocate for more holistic approaches to campus sustainability, ensuring that green practices become core elements of the educational experience, rather than being isolated or temporary initiatives. This ongoing commitment can create a lasting influence on students, preparing them to lead future sustainability efforts in various sectors.

DISCUSSION

The findings highlight the significant role of waste management and sustainability practices in enhancing both the physical and psychological well-being of students. Effective waste management, such as the 3R principles (Reduce, Reuse, Recycle) implemented at universities like Mahasarakham University (Phrophayak et al., 2024) and East China Normal University (Pan

et al., 2022), contributes to cleaner campuses and improved student health. The psychological benefits, such as increased social engagement and environmental stewardship, are also evident, as shown by McGibbon and Van Belle (2015) and Chan et al. (2022).

Integrating sustainability into curricula, as emphasized by Lee and Lee (2022) and Roy (2023), is crucial for preparing students to tackle global environmental challenges. This holistic approach not only promotes green behavior but also fosters future-ready leaders. Moreover, sustainability initiatives create long-term positive impacts, aligning with Fissi et al.'s (2021) argument that continuous engagement and infrastructure improvements are key to sustaining these efforts.

The studies confirm that waste management and sustainability practices positively influence student health and well-being while fostering environmental leadership. Educational institutions that integrate sustainability principles into their curricula and adopt green campus policies equip students with the skills needed to address global challenges. The connection between waste management, sustainability education, and student outcomes is clear, with both physical and psychological benefits.

Future research should explore the effectiveness of sustainability practices across different regions and contexts to improve the generalizability of findings. Additionally, studies should examine the long-term impact of sustainability education on students' careers and social well-being. Further exploration into the use of technology in sustainability practices and a more holistic, standardized approach to integrating sustainability on campuses could enhance the lasting impact of these initiatives. Lastly, research should focus on the social and psychological effects of student engagement in sustainability, further understanding its broader benefits.

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Funding: No outside funding.

Conflict of Interest: The authors declare that there is no conflict of interest regarding the publication of this paper.

Ethical Statement: The study followed the Declaration of Helsinki.