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Workplace Nutrition Interventions: A Systematic Review of Their Effectiveness

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ABSTRACT

Introduction: Workplace nutrition interventions have emerged as a pivotal strategy for enhancing employee health by addressing dietary behaviors and reducing the risk of non-communicable diseases. This systematic review evaluates the effectiveness of workplace-based nutrition interventions in improving nutritional outcomes and health indicators among employees.
Methods: Using the PRISMA framework, a comprehensive search was conducted across PubMed, ScienceDirect, Scopus, and Google Scholar for studies published between 2020 and 2024. Eligible studies included randomized controlled trials (RCTs) and quasi-experimental designs targeting workplace-based nutrition interventions. A total of 10 studies met the inclusion criteria and were systematically analyzed for outcomes related to dietary behavior, physical activity, and health indicators. Risk of bias assessments were performed to ensure the validity of findings.
Results: The findings revealed that dietary interventions, particularly those emphasizing adherence to structured diets like the Mediterranean diet, consistently led to significant improvements in health markers, including reductions in LDL cholesterol and body fat percentage. Interventions combining dietary modifications with physical activity yielded comprehensive benefits, such as weight loss and improved dietary adherence. However, variability in study designs, sample sizes, and contextual factors limited the generalizability of results. Many studies lacked follow-up data to assess the long-term sustainability of health outcomes.
Conclusion: Workplace nutrition interventions promote employee health, especially when combining dietary and physical activity components. However, challenges such as methodological heterogeneity, short-term focus, and limited exploration of demographic and contextual factors must be addressed. Future research should prioritize standardized methodologies, conduct longitudinal assessments, and implement tailored interventions that consider workforce diversity and workplace culture. These findings provide actionable insights for policymakers and employers seeking to design sustainable workplace health initiatives that enhance employee well-being and organizational productivity.

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INTRODUCTION

Workplace nutrition interventions have gained recognition as a crucial strategy for improving employee health, particularly due to the significant time spent in work environments. These settings offer a unique opportunity to influence daily dietary habits, making them ideal for promoting healthier behaviors. The World Health Organization (WHO) has emphasized the workplace as a priority environment for health interventions, highlighting its potential to positively affect dietary practices and reduce the risk of non-communicable diseases such as obesity and cardiovascular conditions(1). Various strategies, such as nutrition education, improved food availability, and dietary guidance, have been implemented to address the increasing burden of diet-related health issues among working (2).

The prevalence of health concerns such as obesity, hypertension, and type 2 diabetes among working adults necessitates effective workplace interventions. Research suggests that workplace programs can effectively reach large populations, providing structured initiatives to improve nutritional literacy and promote long-term healthy eating habits (3). Systematic reviews have indicated significant improvements in employees' dietary intake and health status as a result of these interventions (4), though the outcomes have been inconsistent across various settings (5).

One of the primary challenges in workplace health promotion is the variability in the effectiveness of nutrition-based interventions. While some programs have led to positive changes in dietary behaviors and health markers such as body mass index (BMI) and cholesterol levels, others have produced minimal or inconsistent results (2). This inconsistency can be attributed to differences in intervention design, target populations, and workplace environments (6). For example, interventions incorporating both education and environmental changes tend to show better results than those focusing solely on education (7). To address these discrepancies, a more standardized approach to intervention design is needed. Evidence-based practices adaptable across various workplaces can help ensure consistent effectiveness. By identifying successful components—such as improved food availability, structured education, and behavior change techniques—employers and policymakers can develop interventions tailored to the specific needs of their workforce (8).

Existing literature presents several approaches to workplace nutrition interventions, with varying degrees of success. One prominent method is nutrition education, which provides employees with the knowledge and tools necessary to make healthier food choices. Studies by Hassani et al. (9) and Fitzgerald et al. (10) have demonstrated that structured educational interventions significantly improve nutritional knowledge and dietary habits. These interventions typically include workshops, lectures, and interactive sessions, often supplemented by follow-up support to ensure sustained behavior change.

Another successful strategy is modifying the food environment in workplaces. Research has shown that increasing the availability of healthy food options in cafeterias or vending machines positively influences employees' dietary behavior. For instance, Bandoni et al. (11) found that providing more fruits and vegetables, combined with strategic food presentation techniques, significantly increased healthier food consumption among workers. Environmental modifications, when combined with educational programs, enhance the overall effectiveness of interventions (2). Digital and remote tools have also been explored as an effective way to extend the reach of workplace nutrition programs. While not extensively covered in the references provided, other studies suggest that email-based interventions, which deliver weekly messages promoting healthy eating and physical activity, show promise in maintaining worker engagement (6). These digital approaches are particularly useful for large or geographically dispersed workforces.

Despite the documented short-term benefits of workplace nutrition interventions, including reductions in BMI and improvements in health biomarkers, there remains a notable gap in understanding the long-term sustainability of these health improvements. Review by (2) report positive short-term outcomes but fail to explore the persistence of these benefits beyond the intervention period. This lack of longitudinal research raises concerns about the durability of health gains achieved through workplace programs. Additionally, variability in intervention outcomes across different workplace environments is poorly understood. While comprehensive nutrition programs tend to yield better health outcomes (12), specific contextual factors affecting these results remain underexplored. There is also a lack of research on how improved dietary behaviors translate into broader workplace outcomes, such as increased productivity or reduced absenteeism (2). Furthermore, there is limited evidence on the differential impacts of nutrition interventions on diverse employee populations. Factors like age, gender, and job type may significantly influence individual responses, yet these variables are often overlooked in intervention studies. Tailored approaches are necessary to meet the specific needs of different demographic groups within the workforce (6).

The objective of this systematic review is to evaluate the effectiveness of workplace-based nutrition interventions in improving nutritional outcomes and health indicators among employees. The review systematically

synthesizes evidence from randomized controlled trials (RCTs) and quasi-experimental studies published between 2020 and 2024, analyzing the impact of various intervention strategies, including nutrition education, environmental modifications, and technology-enhanced programs. Additionally, it examines the role of workplace-specific contextual factors and workforce demographics in shaping intervention effectiveness. This study is novel in its comprehensive analysis of both short- and long-term impacts of workplace nutrition interventions, addressing gaps in contextual and demographic factors that have not been adequately explored in prior studies. The review falls within the scope of nutritional epidemiology, emphasizing workplace health promotion. The findings will provide valuable insights for employers and policymakers seeking to implement effective nutrition interventions that yield sustainable improvements in employee health and productivity.

METHOD

This systematic review was conducted following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) framework to ensure a comprehensive and transparent process. A structured search strategy was developed to identify relevant studies from electronic databases, including PubMed, ScienceDirect, Scopus, and Google Scholar, covering the publication period from 2020 to 2024. This timeframe was chosen to ensure the inclusion of the most recent studies reflecting current workplace health policies, technological advancements in intervention delivery, and emerging trends in workplace-based nutrition programs. The selection also aligns with the increasing emphasis on digital health interventions and workplace wellness strategies post-pandemic. The search terms included combinations of keywords such as "workplace nutrition interventions," "employee," “worker”, "dietary behavior," "physical activity," “non-communicable disease”, and "health outcomes." Boolean operators (AND, OR) were used to refine the search.

The study selection process involved four stages: identification, screening, eligibility, and inclusion. The inclusion criteria were: (1) studies evaluating workplace-based nutrition interventions, (2) outcomes related to dietary behavior, physical activity, or health indicators, (3) randomized controlled trials (RCTs) or quasi-experimental designs, and (4) studies involving adult employees. The exclusion criteria included review articles or meta-analyses.

Data extraction was performed using a standardized form to collect key information, with two independent reviewers ensuring accuracy and reliability. The extracted data included study design, population characteristics, intervention type, duration, and outcomes. Any discrepancies between reviewers were resolved through discussion, and if necessary, a third reviewer was consulted to reach a consensus. This process ensured consistency and minimized bias in data collection. A risk of bias assessment was conducted for all included studies using the Cochrane Risk of Bias Tool for RCTs and ROBINS-I tool (Risk of Bias in Non-randomized Studies of Interventions) for non-RCTs. Domains assessed included randomization, allocation concealment, blinding, incomplete data handling, and selective reporting. A PRISMA flow diagram was used to illustrate the study selection process, providing transparency and a clear overview of the systematic approach employed in this review. By adhering to the PRISMA framework, this study ensures rigor and reliability in synthesizing evidence on the effectiveness of workplace nutrition interventions.

RESULTS

Study Selection

The study conducted a comprehensive literature search across multiple databases, including PubMed, ScienceDirect, Scopus, and Google Scholar, to identify relevant studies on workplace nutrition interventions published between 2020 and 2024. A total of 414 records were initially retrieved, of which 5 duplicate records were removed, leaving 409 studies for screening. After a detailed screening process, 388 records were excluded due to irrelevance to the research topic. The remaining 21 studies were assessed for eligibility, with 11 being excluded based on irrelevant outcomes. Ultimately, 10 studies met the inclusion criteria and were included in this systematic review (Figure 1).

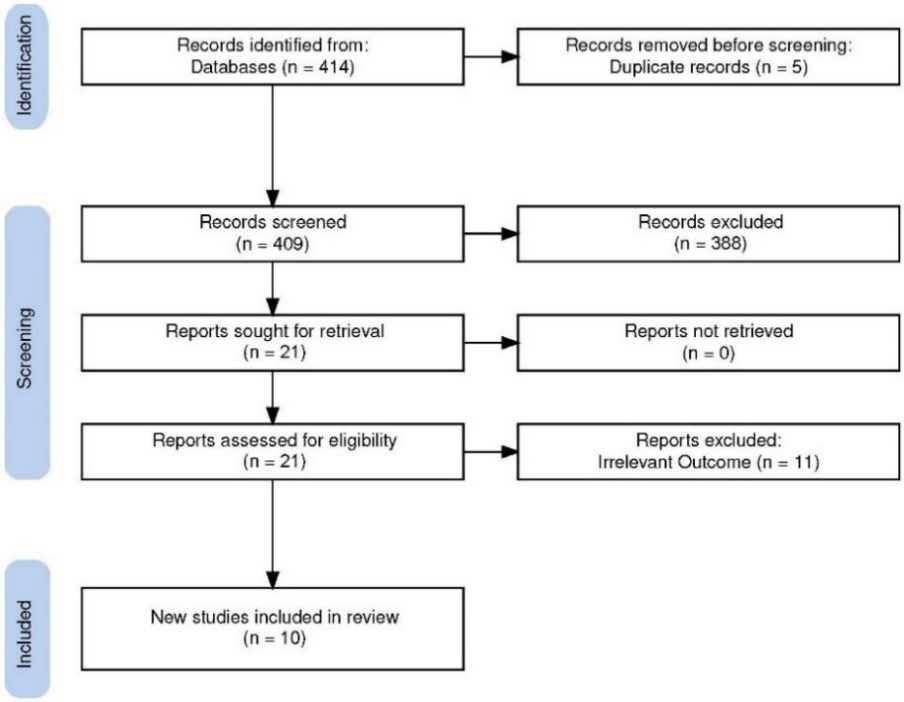

Figure 1. PRISMA flowchart of the study selection process

Study Characteristics

The 10 studies included in this review represent a diverse range of intervention types, populations, and outcomes, reflecting the multifaceted approaches to workplace-based nutrition and health interventions. Eight studies employed randomized controlled trial (RCT) designs, including cluster-randomized and pilot RCTs, to evaluate interventions with controlled comparison groups. Two studies employed diverse non-randomized designs, including a quasi-experimental study and a longitudinal intervention study, each offering valuable quantitative insights into the effects of workplace-based interventions over time. The study populations encompassed various workplace demographics, such as office workers, firefighters, healthcare workers, and mining shift workers, with sample sizes ranging from as few as 48 participants (13) to as many as 485 participants (14). Several studies focused on specific groups, including obese office employees (15) and administrative workers (16).

Intervention types varied, with some studies emphasizing dietary improvements, such as adherence to the Mediterranean diet, while others targeted physical activity through tele-exercise programs or text messaging interventions. Combined strategies incorporating both dietary and physical activity components were also common, often delivered via face-to-face sessions, telehealth platforms, or multicomponent approaches including counseling, environmental changes, and policy modifications. Control groups typically involved participants continuing their usual routines without specific intervention, although some studies provided alternative programs such as generic physical activity information or standard dietary protocols, as seen in the m-DPP comparison in Das et al. (17). The duration of interventions ranged widely, from short-term programs lasting 24 days (18) to extended interventions of up to 18 months (19).

The primary outcomes across the studies focused on weight loss, cardiometabolic markers, dietary adherence, physical activity, and health literacy. Secondary outcomes included improvements in quality of life, adherence to preventive behaviors, and changes in fitness levels or musculoskeletal health. This breadth of study designs, intervention types, and measured outcomes highlights the adaptability of workplace-based interventions to address various health challenges in different populations. However, the diversity also underscores the need for standardized methodologies to improve comparability and generalizability across studies. Table 1 presents the details of each study.

Table 1. Summary of the workplace nutrition interventions impact

Reference	Study Design	Sample	Intervention Group	Control Group	Duration	Outcome
Akksilp et al. (20)	Cluster randomized controlled trial	282 office workers (142 control, 140 intervention)	Multicomponent short-break intervention (individual: pedometer, lottery-based incentives; social: group movement breaks; environmental: posters; organizational: leader encouragement).	Usual routine without any specific intervention	6 months	No significant reduction in sedentary time; slight increase in moderate-to-vigorous physical activity and step count, but not statistically significant.
Das et al., (17)	Randomized controlled trial	238 adult dependents of military personnel with overweight or obesity	Healthy Weight for Living (HWL): A revised health behavior change model emphasizing hunger management and the development of healthy food preferences, delivered primarily by group videoconference with additional midweek emails.	Modified Diabetes Prevention Program (m-DPP): Standard DPP curriculum implemented with counselor time matched to HWL	12 months	Both HWL and m-DPP showed equivalent and clinically impactful mean weight loss (HWL: 7.46 kg; m-DPP: 7.32 kg). Improvements in systolic blood pressure, LDL cholesterol, triglycerides, fasting glucose, general health, sleep, and mood were similar across groups. HWL participants were more adherent to their dietary prescription for lower glycemic index and high fiber.
Hershey et al., (14)	Cluster randomized clinical trial	485 US career firefighters from 52 fire stations (241 intervention, 244 control)	Mediterranean diet intervention with multicomponent strategies: access to supermarket discounts and free samples of Mediterranean diet foods, online nutrition education platforms, email announcements, family and peer education, chef demonstrations, and environmental	Usual care (no specific intervention)	12 months	Significant improvement in Mediterranean diet adherence with an increase of 2.67 points in the modified Mediterranean diet score at 12 months; secondary outcomes showed no significant changes in most cardiometabolic risk factors except for a reduction in body fat percentage and LDL cholesterol at 6 months.

Reference	Study Design	Sample	Intervention Group	Control Group	Duration	Outcome
			modifications at fire stations and homes.			
Kuswari et al., (15)	Pretest-Posttest Quasi-Experimental	63 obese office employees in Jakarta (25 tele-exercise, 38 combined)	Tele-exercise group: 30-minute sessions three times per week for 6 weeks; Combined group: Tele-exercise plus daily nutrition counseling via WhatsApp	Tele-exercise only group (no nutrition counseling)	6 weeks	Significant weight loss in combined group (tele-exercise + tele-counseling: Δ=-1.87 kg, $p<0.05$); no significant change in tele-exercise only group (Δ=0.36 kg, $p>0.05$)
Meyn et al., (19)	Longitudinal intervention study	144 German office workers from a large engineering company (30.0% female)	3-week full-time workplace health promotion program (WHPP) focused on food literacy (FL) and dietary intake (DI): included medical checks, motivational interviewing, daily physical activity sessions, nutrition education, individual coaching, workshops, and take-home materials.	None (no control group)	1.5 years (3 weeks initial intervention with 18 months follow-up)	Significant short- and long-term improvements in FL ($\beta = 0.52$, $p < 0.0001$ at 3 weeks; $\beta = 0.55$, $p < 0.0001$ at 18 months) and DI ($\beta = 0.63$, $p < 0.0001$ at 3 weeks; $\beta = 0.10$, $p < 0.0001$ at 18 months). FL significantly predicted DI across all time points ($\beta = 0.24$, $p < 0.0001$).
Monnaatsie et al., (18)	Randomized controlled trial	60 mining shift workers (30 intervention, 30 control)	Text messaging intervention aimed at promoting physical activity, including tailored messages sent five days per week, action planning sessions, and the use of the Mi fitness band for monitoring physical activity.	Received generic physical activity information but no tailored messages or action planning.	24 days	The intervention reached 66% of shift workers; high adherence with 85% completion rate; increased awareness and motivation for physical activity; barriers included work-related fatigue and shift changes.
Pourhaji et al., (21)	Randomized controlled trial	112 healthcare workers (38 intervention group 1, 37 intervention group 2, 37 control)	Intervention group 1: Interactive educational media intervention via mobile app with weekly reminders; Intervention group 2: In-person education sessions	No education or intervention provided	6 and 12 months	Significant improvement in knowledge, attitude, self-efficacy, enabling factors, reinforcing factors, quality of life, public health, and LBP preventive behaviors in both

Reference	Study Design	Sample	Intervention Group	Control Group	Duration	Outcome
			(2 sessions, 60 minutes each) with weekly reminders.			intervention groups; no significant changes in the control group.
Rafatifard et al., (22)	Randomized controlled trial	170 administrative employees (85 intervention, 85 control)	Interventions based on a comprehensive model, including environmental changes, policy modifications, training sessions, daily advice, and a range of physical activities (work and home-based) with regular follow-ups and support.	No intervention provided	6 months	Significant improvements in physical activity levels, cardiorespiratory fitness, muscular endurance, flexibility, and body composition in the intervention group compared to the control group.
Sotos-Prieto et al., (13)	Pilot cluster-randomized controlled trial	48 firefighters from Indianapolis fire stations (24 intervention, 24 control)	Mediterranean diet intervention: Educational sessions, leaflets, recipes modified to MedDiet, cooking demonstrations, food samples, and discounts for Mediterranean foods, self-sustained phase.	Control group initially followed a regular diet for 12 months, then crossed over to receive the MedDiet intervention for 6 months.	12 months (initial) + 6 months (self-sustained phase) for intervention group; 6 months for control group after crossover	Favorable changes in biomarkers related to lipid metabolism (LDL-C, ApoB/ApoA1 ratio, remnant cholesterol, M-VLDL-CE, HDL-C, and better lipoprotein composition). Modest changes in adherence to MedDiet and metabolic biomarkers overall.
Maciel et al., (16)	Cluster randomized controlled trial	326 administrative workers at a public university in Brazil (178 intervention, 148 control)	Telehealth program with extended care: Audiovisual content focused on musculoskeletal health, healthy diet, and mental health with tutor support available online to clarify doubts and encourage participation.	Control group received the same audiovisual content but without tutor support.	6 months	Significant improvements in general health and environmental domain quality of life measures in the intervention group; no significant differences in the level of physical activity between the intervention and control groups.

The findings highlight both the potential and challenges of workplace nutrition interventions in promoting employee health and productivity. Dietary-focused interventions, particularly those emphasizing adherence to the Mediterranean diet, consistently demonstrated significant improvements in health markers such as LDL cholesterol reduction and decreased body fat percentage (13,14). These results suggest that structured dietary programs, especially those supported by education and environmental modifications, are highly effective in workplace settings.

Interventions that integrated dietary modifications with physical activity yielded broader benefits, including sustained weight loss and improved dietary adherence (15). However, physical activity-only interventions faced difficulties in maintaining participant engagement and achieving long-term behavior changes (18,20). The effectiveness of these interventions varied significantly due to differences in study design, intervention duration, delivery methods, and workplace settings. Notably, interventions that incorporated face-to-face engagement demonstrated stronger adherence and better health outcomes compared to remote or digital-only strategies. Despite promising short-term results, a key limitation across studies was the lack of follow-up data to assess the long-term sustainability of health improvements. Additionally, demographic factors such as age, gender, job type, and work schedules were often underexplored, limiting insights into how different workforce subgroups responded to interventions. From a practical standpoint, these findings emphasize the need for employers to tailor workplace nutrition interventions to specific workforce needs, combining multiple strategies such as real-time engagement, structured dietary education, and environmental modifications to maximize effectiveness. Future research should focus on developing scalable and adaptable interventions that account for workforce diversity and intervention sustainability. Addressing these gaps will be critical in ensuring that workplace-based nutrition programs lead to long-term health improvements and enhanced productivity while overcoming variability in outcomes across different workplace environments.

Risk of Bias Assessment

The risk of bias assessment revealed variations in methodological quality across the 10 included studies, with randomized controlled trials (RCTs) generally demonstrating lower risk of bias compared to non-randomized studies. For the RCTs, the randomization process was well-documented, leading to a low risk of bias in this domain across all studies. Allocation concealment was similarly robust for these studies, ensuring that group assignments were adequately hidden, thus maintaining the integrity of the randomization. However, blinding of assessors presented challenges, with some studies, such as Maciel et al. (16), showing unclear or high risk of bias in this domain, which may have introduced measurement bias in subjective outcomes. A summary of the risk of bias assessment is presented in Table 2.

Table 2. Summary of the risk of bias assessment

Reference	Study Type	Randomization/Confounding	Allocation Concealment	Blinding (Assessor)	Incomplete Data	Selective Reporting
Akksilp et al., 2023	RCT	+	+	?	+	+
Das et al., 2021	RCT	+	+	+	+	+
Hershey et al., 2023	RCT	+	+	+	+	+
Kuswari et al., 2021	Non-RCT	− (Confounding)	N/A	−	+	+
Meyn et al., 2022	Non-RCT	− (Confounding)	N/A	−	−	+
Monnaatsie et al., 2023	Non-RCT	+	+	?	+	+
Pourhaji et al., 2020	RCT	+	+	?	+	+
Rafatifard et al., 2020	RCT	+	+	?	+	+
Sotos-Prieto et al., 2020	RCT	+	+	+	+	+
Maciel et al., 2021	RCT	+	+	?	+	+

+ = low risk of bias; - = high risk of bias; and ? = unclear risk of bias

For non-randomized studies, confounding emerged as a significant source of bias. Studies such as Kuswari et al. (15) and Meyn et al. (19) faced high risks in this area due to the lack of randomization and insufficient control for variables that could influence outcomes. Similarly, the absence of blinding in non-RCTs further compounded the risk of bias in outcome measurement. Despite these limitations, both RCTs and non-RCTs performed well in handling incomplete data, with most studies demonstrating low risk in this domain. Selective reporting was also consistently low risk across all studies, indicating that outcomes were reported as pre-specified, without evidence of result manipulation.

Overall, RCTs displayed more robust methodologies compared to non-RCTs, particularly in domains related to randomization and allocation concealment. However, the lack of blinding, particularly in non-RCTs and some

RCTs, highlights a recurring limitation that could influence the validity of measured outcomes. These findings underscore the importance of improving methodological rigor in future workplace-based intervention studies to enhance the reliability of their conclusions.

Effectiveness of Dietary and Physical Activity Interventions

The studies focusing on dietary and physical activity interventions revealed notable findings across a range of outcomes. Dietary interventions, especially those emphasizing Mediterranean diet adherence, consistently showed positive outcomes. For instance, Hershey et al. (14) and Sotos-Prieto et al. (13) demonstrated improved adherence to the Mediterranean diet and significant reductions in LDL cholesterol and body fat percentage. In contrast, physical activity-focused interventions, such as those in Akksilp et al. (20) and Monnaatsie et al. (18), often struggled to achieve substantial increases in physical activity, indicating challenges in sustaining behavioral changes. Interventions integrating both dietary and physical activity components, such as in Kuswari et al. (15), yielded more comprehensive benefits, including weight loss and improved dietary adherence. A recurring theme is that dietary interventions tend to outperform physical activity-only interventions in terms of measurable health improvements. This is particularly evident when dietary changes are supported by counseling or environmental modifications. Key differences include the delivery methods: face-to-face dietary education often showed greater adherence and outcomes compared to remote or text-based physical activity interventions. Additionally, physical activity interventions often faced barriers like participant adherence and fatigue, limiting their effectiveness.

Effectiveness of Telehealth-Based Interventions

Telehealth interventions showcased mixed effectiveness depending on their structure and delivery. Studies like Kuswari et al. (15) demonstrated that tele-exercise combined with tele-counseling led to significant weight loss, while interventions relying solely on tele-exercise, such as in Maciel et al. (16), failed to achieve similar results. Text messaging interventions, as explored by Monnaatsie et al. (18), increased awareness and motivation but struggled to sustain long-term physical activity changes. These findings highlight the variability in outcomes based on the complexity and interactivity of the telehealth intervention. Common themes include the importance of interactive and feedback-driven components in telehealth interventions. Programs that provided real-time support or counseling tended to yield better adherence and health outcomes than those relying solely on passive methods like text messaging. The key difference lies in the level of participant engagement; interventions incorporating active communication (e.g., tele-counseling in Kuswari et al., (15)) were more successful than those using one-directional communication, as seen in Monnaatsie et al. (18).

Weight Loss and Cardiometabolic Outcomes

Weight loss and cardiometabolic outcomes were central to many interventions, with varying levels of success. Significant weight loss was observed in studies such as Das et al. (17) and Kuswari et al. (15), where tailored dietary and physical activity interventions were implemented. Cardiometabolic improvements, including reductions in LDL cholesterol, blood pressure, and triglycerides, were reported in studies like Hershey et al. (14) and Sotos-Prieto et al. (13). However, interventions solely focusing on physical activity, such as Akksilp et al. (20), failed to show substantial weight loss or improvements in metabolic markers. A common theme across studies is that dietary interventions or combined approaches were more effective in achieving weight loss and cardiometabolic improvements than physical activity interventions alone. Key differences were evident in intervention intensity and duration. For example, longer and more structured programs, such as the Mediterranean diet intervention in Hershey et al. (14), were associated with better outcomes than shorter interventions or those with limited participant engagement.

Behavioral Improvements and Health Literacy

Behavioral improvements and health literacy outcomes were prominently featured in several studies, with significant gains reported. For example, Meyn et al. (19) showed long-term improvements in food literacy, which directly influenced dietary behavior over time. Similarly, Pourhaji et al. (21) demonstrated significant improvements in self-efficacy, quality of life, and preventive health behaviors following educational interventions. However, studies like Monnaatsie et al. (18), which focused on motivational interventions, found increased awareness but limited evidence of sustained behavioral change. The findings highlight the importance of integrating educational and literacy-focused components into workplace interventions. Programs incorporating interactive and tailored educational strategies tended to produce more durable behavioral improvements compared to passive approaches. A

notable difference among the studies was the duration of the intervention's impact. Long-term programs, such as those in Meyn et al. (19), maintained behavioral improvements, while short-term interventions often showed diminishing effects after the program concluded. This underscores the value of sustained engagement and follow-up to reinforce behavioral changes.

DISCUSSION

The review findings regarding dietary and physical activity interventions reveal a complex landscape of outcomes that underscore the importance of both dietary adherence and physical activity in promoting health. A significant body of literature indicates that dietary interventions, particularly those centered around the Mediterranean diet, consistently yield positive health outcomes. For instance, studies highlight that adherence to the Mediterranean diet is associated with marked reductions in LDL cholesterol and body fat percentage, suggesting that dietary modifications can lead to substantial improvements in cardiovascular health and body composition (23). In contrast, interventions focused solely on physical activity often encounter challenges in achieving sustained behavioral changes. Reports indicate that physical activity interventions frequently struggle to produce significant increases in participants' activity levels, indicating that merely encouraging physical activity may not be sufficient for long-term adherence (24). This disparity in outcomes suggests that dietary interventions may be inherently more effective than physical activity-only interventions, particularly when they are supported by counseling or environmental modifications. The evidence indicates that face-to-face dietary education tends to foster greater adherence and more favorable outcomes compared to remote or text-based physical activity interventions, which may lack the personal engagement necessary for effective behavior change (25).

Interventions that integrate both dietary and physical activity components tend to yield more comprehensive benefits. These studies suggest that the combination of dietary changes and increased physical activity can lead to significant weight loss and improved dietary adherence, highlighting the synergistic effects of these interventions (26). The findings align with the broader literature that emphasizes the need for integrated approaches to health promotion, as isolated interventions may not address the multifactorial nature of obesity and chronic disease (27). Notably, the literature highlights a consistent trend where dietary interventions tend to surpass those focused solely on physical activity in achieving measurable health outcomes. This trend is particularly pronounced when dietary changes are reinforced by supportive counseling or environmental modifications. For instance, interventions incorporating behavioral change techniques, including social support and goal setting, were more successful in promoting dietary adherence compared to those focused solely on physical activity (28). Similarly, a study found a dose-response relationship between the frequency of engagement with online physical activity interventions and improvements in weight and physical activity levels, suggesting that the effectiveness of these interventions may be contingent upon sustained engagement (29). The barriers faced by physical activity interventions are also noteworthy. Many participants report challenges such as fatigue and lack of motivation, which can hinder their ability to maintain increased activity levels over time. This is consistent with findings that interventions solely focused on physical activity often yielded limited improvements in social participation and overall fitness (30). The complexity of behavior change in physical activity contexts is further underscored by the work indicating that while physical literacy-related interventions can be successful, they often require a multifaceted approach to engage participants effectively (31).

Recent studies on telehealth interventions reveal a complex landscape of effectiveness, heavily influenced by the structure and delivery methods employed. As evidenced by Kuswari et al. (15), tele-exercise combined with tele-counseling resulted in significant weight loss, indicating that interventions incorporating interactive elements tend to yield better outcomes. In contrast, Maciel et al. (16) highlighted that tele-exercise alone did not achieve similar results, suggesting that the absence of interactive components may limit the effectiveness of such interventions. This disparity underscores the importance of participant engagement and the necessity for telehealth programs to incorporate multifaceted approaches that include real-time support and feedback mechanisms (32). Moreover, Monnaatsie et al. (18) explored text messaging interventions, which, while effective in increasing awareness and motivation, struggled to maintain long-term changes in physical activity. This finding aligns with the broader theme that passive methods, such as one-directional communication, are less effective than those that foster active engagement. The variability in outcomes across different telehealth interventions suggests that the complexity and interactivity of the program play a crucial role in determining its success (33). The literature consistently emphasizes the significance of interactive and feedback-driven components in telehealth interventions. Programs that provide real-time support, such as tele-counseling, have been shown to enhance adherence and health outcomes compared to those that rely solely on passive

methods. For instance, the findings from Kuswari et al. (15) demonstrate that active communication leads to better participant engagement, which is critical for achieving desired health outcomes. In contrast, Monnaatsie et al. (18) illustrate the limitations of one-directional communication, highlighting the need for telehealth interventions to foster two-way interactions to sustain long-term behavior changes.

The effectiveness of telehealth interventions is further influenced by the specific health conditions being addressed. Xiang et al. (32) conducted a systematic review and meta-analysis on telehealth-supported exercise programs for knee osteoarthritis, revealing that structured, interactive programs significantly improved patient outcomes compared to less engaging alternatives. This finding reinforces the notion that the design and delivery of telehealth interventions must be tailored to the unique needs of the target population to maximize effectiveness (34). Furthermore, the integration of telehealth into existing healthcare frameworks poses both challenges and opportunities. Studies such as those by Zhai et al. (35) highlight the necessity for ongoing research to assess therapeutic outcomes between in-person and telehealth counseling. These studies suggest that while telehealth can enhance access to care, particularly in underserved areas, the effectiveness of these interventions may vary based on the specific context and population served (36). The COVID-19 pandemic has accelerated the adoption of telehealth services, prompting a reevaluation of traditional healthcare delivery models. As noted by Gilkey et al., (37), the rapid transition to telehealth has highlighted both the potential benefits and the barriers to effective implementation. The expansion of telehealth services has been associated with increased patient satisfaction and improved access to care, particularly for populations that have historically faced challenges in accessing healthcare services (38,39). However, the sustainability of telehealth interventions remains a critical concern. Studies like those by Butzner & Cuffee (40) emphasize the importance of developing robust frameworks to support the long-term integration of telehealth into healthcare systems. These frameworks should address issues such as reimbursement policies, technological infrastructure, and training for healthcare providers to ensure that telehealth services can be effectively maintained and scaled (41,42).

The review of weight loss and cardiometabolic outcomes across various interventions reveals a complex interplay between dietary modifications, physical activity, and the overall effectiveness of these strategies. A significant body of literature indicates that tailored dietary and physical activity interventions yield substantial weight loss and improvements in cardiometabolic markers. For instance, studies by Zaghloul et al. (43) and Geurts (44) illustrate that personalized approaches, which integrate dietary changes with physical activity, lead to notable reductions in body weight and enhancements in metabolic health parameters. These findings align with the broader consensus that interventions combining dietary and physical activity components are more effective than those focusing solely on one aspect. In contrast, interventions that emphasize physical activity alone, such as the one conducted by Akksilp et al. (20), often fail to produce significant weight loss or improvements in metabolic markers. This discrepancy underscores the importance of dietary interventions in achieving desired outcomes. The systematic review by Geurts (44) supports this assertion, noting that the combination of eHealth tools with dietary guidance significantly enhances weight loss compared to physical activity interventions alone. Furthermore, the review highlights that participants engaged in comprehensive dietary programs tend to experience greater reductions in LDL cholesterol, blood pressure, and triglycerides, as evidenced by studies like those conducted by Carneiro-Barrera et al. (45) and Webb et al. (46).

A recurring theme across these studies is the effectiveness of dietary interventions, particularly when they are structured and sustained over longer periods. For example, the Mediterranean diet intervention reported by Carneiro-Barrera et al. (45) demonstrated superior outcomes compared to shorter or less engaging programs. This finding is corroborated by the systematic This finding is corroborated by the systematic review conducted by Zaghloul et al. (43), which emphasizes the positive impact of combining exercise with dietary interventions on weight loss and obesity-related complications in the Middle East and North Africa region. The evidence suggests that longer, more intensive programs facilitate better adherence and more significant health improvements. Moreover, the intensity and duration of interventions play a critical role in their success. Studies indicate that longer interventions, such as those exceeding 12 months, yield more substantial weight loss and cardiometabolic benefits compared to shorter interventions. For instance, a meta-analysis by Webb et al. (46) found that comprehensive dietary weight loss programs are associated with significant improvements in physical function and metabolic health, particularly in populations with specific health conditions such as osteoarthritis.

The psychological aspects of dietary adherence also emerge as a crucial factor influencing the effectiveness of weight loss interventions. Research indicates that behavioral change techniques, such as self-monitoring and goal setting, significantly enhance adherence to dietary guidelines and weight loss outcomes. For example, the study by

Horne et al. (47) highlights the role of personalized avatars in improving engagement and adherence in weight loss programs, suggesting that innovative approaches can lead to better outcomes. Additionally, the systematic review by Raber et al. (48) emphasizes the importance of dietary self-monitoring as a key component of successful behavioral weight loss interventions, further supporting the notion that psychological factors are integral to achieving and maintaining weight loss.

The review findings on behavioral improvements and health literacy outcomes reveal a significant trend towards the effectiveness of educational interventions in various settings, particularly in workplace environments. Several studies have highlighted the positive impact of these interventions on health literacy and behavioral changes. For instance, Meyn et al. (19) demonstrated that long-term improvements in food literacy significantly influenced dietary behavior over time, suggesting that sustained educational efforts can lead to lasting changes in health-related behaviors. Similarly, Walters et al. (49) reported significant enhancements in self-efficacy, quality of life, and preventive health behaviors following educational interventions, underscoring the potential of structured educational programs to foster positive health outcomes. In contrast, Canady & Larzo (50) focused on motivational interventions and found that while there was an increase in awareness, the evidence for sustained behavioral change was limited. This discrepancy highlights the complexity of behavioral change, where mere awareness does not necessarily translate into long-term action. The findings from these studies collectively emphasize the necessity of integrating educational and literacy-focused components into workplace interventions to achieve meaningful health outcomes.

The duration of the intervention's impact is another critical factor that emerged from the review. Long-term programs, such as those implemented by Meyn et al. (19), maintained behavioral improvements over time, while short-term interventions often showed diminishing effects after the program concluded. The literature suggests that sustained engagement and follow-up are essential components in reinforcing behavioral changes, as they provide ongoing support and motivation for individuals to maintain their new health behaviors (51). Moreover, the method of delivery for educational interventions plays a significant role in their effectiveness. Cheung (52) found that web-based approaches are viable and effective strategies for improving mental health literacy among healthcare professionals, indicating that digital platforms can enhance accessibility and engagement in health education. This finding is corroborated by Walters et al., (49), who established the efficacy of various interventions aimed at improving health literacy and health behaviors, suggesting that diverse delivery methods can cater to different learning preferences and contexts. The integration of technology in health literacy interventions can also facilitate broader reach and inclusivity, particularly for populations that may face barriers to traditional educational formats (53).

The importance of tailoring interventions to specific populations and contexts cannot be overstated. Guo et al. (51) highlighted the need for school-based interventions that not only focus on knowledge dissemination but also empower children with personal skills to protect and maintain their health. This approach aligns with the findings of López (54), who emphasized that health literacy interventions must address the unique needs and circumstances of the target audience to be effective. By customizing educational content and delivery methods, programs can enhance their relevance and impact, ultimately leading to better health outcomes. Furthermore, the role of health literacy in promoting positive health behaviors is well-documented. Studies have shown that individuals with higher health literacy levels are more likely to engage in preventive health behaviors and make informed health decisions (55). For example, Lindert et al. (53) discussed the significance of organizational health literacy in improving employee well-being and health outcomes, suggesting that workplace interventions should prioritize health literacy as a foundational element. This is particularly relevant in male-dominated occupations, where targeted health literacy programs can address specific health risks and promote healthier behaviors among employees (56).

Despite the meaningful contributions of this study, several limitations warrant acknowledgment. One significant constraint lies in the relatively small sample sizes observed in some of the included studies, which may limit the generalizability of the findings. For instance, studies such as those by Kuswari et al. and Monnaatsie et al. had fewer than 100 participants, reducing the ability to draw broad conclusions. Additionally, the heterogeneity in study designs, encompassing variations in intervention types, durations, and target populations, complicates direct comparisons between studies and introduces potential bias. A notable limitation is the short-term focus of many included studies, which often lacked follow-up periods necessary to assess the sustainability of health improvements. This shortcoming restricts our understanding of the long-term effectiveness of workplace nutrition interventions. Another critical issue is the lack of blinding in several studies, particularly non-randomized ones, which may have introduced measurement biases, especially in self-reported outcomes. Furthermore, the influence of contextual factors such as workplace culture or economic constraints was underexplored, which could affect the adaptability of these

interventions to various settings. Lastly, the studies included limited examination of demographic factors like age, gender, and job type, leaving gaps in understanding the differential impacts of these interventions on diverse employee populations. These limitations should be considered when interpreting the results of this systematic review.

Recommendations for Future Research

Building on the insights gained from this study, several avenues for future research are recommended to address the identified limitations and advance the field of workplace nutrition interventions. Firstly, larger-scale studies with diverse workplace settings should be conducted to enhance the generalizability of findings and identify the context-specific factors influencing intervention success. Efforts should also focus on standardizing methodologies across studies, including intervention protocols and outcome measures, to improve reliability and enable meaningful meta-analyses. The need for longitudinal studies is evident, as these would provide insights into the sustainability of health benefits and their long-term impact on employee productivity and absenteeism. In addition to research advancements, stakeholders, including workplace administrators, policymakers, and health professionals, must take an active role in optimizing the effectiveness of workplace nutrition programs. Employers should consider integrating comprehensive, multi-component interventions that combine dietary modifications with physical activity initiatives and behavioral support. Providing accessible nutrition education, improving healthy food availability, and leveraging digital tools such as telehealth services and wearable health-tracking devices can enhance participation and adherence. Policymakers should prioritize the development of guidelines and incentives that support the implementation of standardized, evidence-based workplace nutrition programs. This includes fostering collaborations between public health agencies, employers, and researchers to ensure best practices are adopted across different industries and workforce demographics. Additionally, policymakers can encourage businesses to incorporate workplace wellness programs into broader occupational health policies by offering tax incentives or financial support for organizations that implement structured nutrition interventions. From an organizational perspective, human resource departments and corporate wellness teams should tailor interventions to address demographic differences, job types, and workplace culture. Personalized approaches, such as adjusting dietary recommendations based on employees' health profiles or work schedules, can improve intervention effectiveness. Further, fostering a supportive workplace environment that encourages participation, such as offering incentives for healthy behaviors and providing time for wellness activities during work hours, can enhance long-term engagement. Finally, future research should extend its focus beyond health markers to measure broader organizational outcomes, such as job satisfaction, productivity gains, and healthcare cost reductions. By addressing these areas, workplace nutrition interventions can transition from being solely health-focused to a strategic investment in workforce performance and well-being. Strengthening collaboration between researchers, employers, and policymakers will be key to refining intervention strategies and ensuring sustainable health improvements among employees.

CONCLUSION

This systematic review highlights the effectiveness and challenges of workplace nutrition interventions in improving employee health outcomes. Dietary interventions, particularly those emphasizing adherence to structured diets like the Mediterranean diet, consistently demonstrated significant health benefits, including reductions in LDL cholesterol and body fat percentage. Interventions combining dietary changes with physical activity yielded the most comprehensive outcomes, underscoring the need for multifaceted approaches to health promotion. However, variability in study designs, small sample sizes, and limited exploration of long-term impacts restrict the generalizability of the findings. The lack of attention to contextual and demographic factors further limits the adaptability of interventions to diverse workplace settings. Future research should prioritize methodological standardization, larger sample sizes, longitudinal studies, and the integration of advanced technologies to address these limitations. By addressing these gaps, future studies can pave the way for more effective, sustainable workplace nutrition interventions that improve employee health while contributing to organizational productivity and well-being. Policymakers and workplace administrators should standardize methodologies, leverage technology, tailor interventions to demographics, and ensure long-term follow-ups for sustained effectiveness.

AUTHOR'S CONTRIBUTION STATEMENT

RR: conceptualized the study, led the systematic review process, and contributed to data analysis and manuscript writing; NRH: designed the search strategy, performed database searches, and assisted in the critical appraisal of included studies; HF: data extraction, interpretation of results, and drafting sections of the manuscript;

MEF: oversaw the risk of bias assessment, and drafting sections of the manuscript. All authors read and approved the final version of the manuscript and take responsibility for its accuracy and integrity.

CONFLICTS OF INTEREST

The authors declare no conflicts of interest related to this study. They have no financial or personal relationships with any organizations or entities that could influence or bias the results and conclusions presented in this manuscript. This declaration ensures the transparency and integrity of the research findings.

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