TRAINING DIETETIC TECHNICIANS THROUGH DISTANCE LEARNING: CHALLENGES, OPPORTUNITIES, AND IMPACT ON THE LABOR MARKET

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Abstract: Introduction: The growing demand for Nutrition and Dietetic Technicians, Registered (NDTR) in the United States, combined with the contraction in accredited program offerings and geographic inequalities in access to professional education, creates a structural gap in the American nutritional health system. Distance learning (DL) emerges as a promising strategy to address this deficit, but lacks a systematized synthesis evaluating its feasibility and impact. Objective: To synthesize available evidence on the effectiveness, curricular structure, and socioeconomic impact of DL applied to dietetic technician training, identifying the most appropriate educational technologies for remote practical instruction and the implications for public education policies. Methodology: Systematic literature review conducted following PRISMA 2020 guidelines (PAGE et al., 2021), with searches in PubMed/MEDLINE, ERIC, Web of Science, and Scopus databases, covering publications from January 2021 to December 2025. Descriptors included combinations of "dietetic technician," "NDTR," "distance education," "nutrition education," "online learning," "blended learning," "health professions education," and "virtual simulation." The PICO framework guided the research question and eligibility criteria. Thirty-two studies were included after screening by titles, abstracts, and full text, with methodological quality assessed using JBI and MERSQI instruments. Results: The COVID-19 pandemic accelerated digital transformation in health professions education, consolidating hybrid and remote models (JEFFRIES et al., 2022). In 2025, only 18 NDTR programs remained

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accredited by ACEND in the United States, with four offering fully online didactic curricula. The labor market projects 6% employment growth in nutrition between 2024 and 2034, with a growing deficit of qualified professionals (BUREAU OF LABOR STATISTICS, 2024). Virtual simulation, problem-based learning, and synchronous platforms proved effective for developing practical competencies at a distance (MITCHELL; IVIMEY-COOK, 2023; RUSLI; SEAH; LEVETT-JONES, 2022). The hybrid model with local supervised in-person practice showed superior academic performance compared to conventional instruction (HUAI et al., 2024). Discussion and Conclusion: DL represents a strategic opportunity to democratize NDTR training, with significant socioeconomic impact. Its implementation requires a robust theoretical framework — Transactional Distance Theory and the Community of Inquiry Framework —, curricular structure aligned with ACEND, public policies for digital equity, and primary research specifically focused on the NDTR population. The scarcity of primary studies focused on dietetic technicians constitutes the main limitation of the current synthesis and points to an urgent and necessary research agenda.

Keywords: dietetic technician; NDTR; distance learning; nutrition education; labor market; educational technologies; digital equity; United States.

INTRODUCTION

Health and human nutrition constitute structural pillars of contemporary health systems. In the United States, the growing prevalence of chronic non-communicable diseases — such as type 2 diabetes, obesity, arterial hypertension, and cardiovascular diseases — exponentially amplifies the demand for specialized services in clinical, community, and food service nutrition. In this context, dietetic technicians, known as Nutrition and Dietetic Technicians, Registered (NDTR), play a strategic role as intermediate-level professionals who work under the supervision of Registered Dietitian Nutritionists (RDN), providing qualified support in nutritional assessment, menu planning,

food education, and food service management.

Despite their relevance, the training of dietetic technicians in the United States faces an acute structural crisis. The number of programs accredited by the Accreditation Council for Education in Nutrition and Dietetics (ACEND) has declined significantly in recent decades due to a combination of factors: low enrollment, budgetary constraints at community colleges historically responsible for the majority of NDTR offerings, competition with four-year undergraduate programs, and, as of January 2024, the master's degree requirement for credentialing new RDNs — a change that diverted institutional resources away from technical programs (ACCREDITATION COUNCIL FOR EDUCATION IN NUTRITION AND DIETETICS, 2022). As of September 2025, only 18 NDTR programs remained accredited in 12 U.S. states, with an even smaller number in full operation.

This scenario of supply contraction contrasts sharply with labor market projections. According to the Bureau of Labor Statistics (2024), employment of dietitians and nutritionists is expected to grow 6% between 2024 and 2034 — a rate faster than the overall average for all occupations — with approximately 6,200 job openings per year over the next decade. Davis, Vogelzang, and Affenito (2023), in an article published in the Journal of the Academy of Nutrition and Dietetics, warn that the shortage of qualified nutrition professionals at all levels threatens the sustainability of the American nutritional health system, compromising the quality of services provided to the population, especially to vulnerable communities.

Simultaneously, distance learning (DL) has established itself as a legitimate, effective, and accessible educational modality for the training of health professionals. The COVID-19 pandemic served as an unprecedented catalyst for this transformation: Jeffries et al. (2022), in a review published in Academic Medicine, documented that the need for physical distancing rapidly increased the online offering of health professions education, accelerating the adoption of technologies that were already recognized as necessary but systematically postponed. In the specific field of nutrition and dietetics, Bueche et al. (2023) demonstrated, in a narrative review spanning 30 years of literature published in the Journal of the Academy of Nutrition and Dietetics, that attitudes and perceptions about DL

changed progressively as barriers to internet access diminished and accredited distance programs expanded.

This systematic literature review aims to investigate, in an integrated and rigorous manner, the feasibility, effectiveness, and socioeconomic impact of DL applied to the training of dietetic technicians, with a focus on the North American context. The research is guided by the following questions: What is the evidence on the effectiveness of DL in the training of health professionals in general and nutrition and dietetics professionals in particular? What theoretical frameworks support the design of quality online NDTR programs? Which technological tools are most appropriate for remote practical instruction? What are the structural elements of an online curriculum for dietetic technicians capable of meeting ACEND regulatory requirements? What is the potential socioeconomic impact of such an initiative? And what are the implications for public educational and health policies?

The relevance of this investigation is multidimensional. From an educational standpoint, it contributes to the literature on instructional design and technologies for practical instruction in health professions. From a professional standpoint, it provides insights for credentialing programs and institutions wishing to develop or improve online formats for NDTR training. From a socioeconomic standpoint, it signals concrete opportunities for expanding access to education, generating qualified employment, and strengthening equity in nutritional health.

THEORETICAL FRAMEWORK

The theoretical foundation of this review is anchored in two frameworks consolidated in the health distance education literature: Moore's Transactional Distance Theory and the Community of Inquiry (CoI) Framework by Garrison, Anderson, and Archer. The articulation between these two perspectives offers a robust conceptual basis for understanding both the mechanisms of learning in virtual environments and the structural conditions that determine their effectiveness.

Transactional Distance Theory

The Transactional Distance Theory (TDT), formulated by Michael G. Moore, proposes that the central phenomenon of distance education is not the physical separation between student and teacher, but the psychological and communicational distance — the transactional distance — generated by this separation. According to the theory, transactional distance is determined by the interaction between three elements: dialogue (interactive communication between teacher and student), structure (the rigidity or flexibility of the educational program), and learner autonomy (the student's capacity to self-direct their learning). The greater the dialogue and the greater the structural flexibility, the smaller the transactional distance and the higher the quality of learning (ABUHASSNA; ALNAWAJHA, 2023).

Roach and Attardi (2022), in an article published in Medical Teacher with twelve tips for applying TDT in health professions education, demonstrate that the theory provides concrete practical guidance for the design, delivery, and refinement of online courses. The authors identify specific strategies to reduce transactional distance in health courses: frequency and quality of synchronous interactions between teacher and student, design of activities that promote progressive autonomy, timely formative feedback, and personalization of learner support. In the context of online NDTR training, TDT guides the construction of learning environments that compensate for the absence of physical presence, ensuring a high degree of interactivity and individualized support.

Community of Inquiry Framework

The Community of Inquiry (CoI) Framework, developed by Garrison, Anderson, and Archer and published in Internet and Higher Education in 2000, constitutes one of the most influential and empirically supported models for understanding collaborative online learning experiences. The CoI describes effective online educational environments as the product of the intersection of three

interdependent elements: cognitive presence (participants' ability to construct meaning through sustained reflection and discourse), social presence (participants' ability to project themselves as "real people" in the online environment), and teaching presence (the design, facilitation, and direction of cognitive and social processes toward meaningful learning outcomes) (GARRISON; ANDERSON; ARCHER, 2000).

In health education, the CoI has been widely adopted as a guiding model for hybrid and online learning environments. MacNeill et al. (2024), in AMEE Guides 161 and 163 on online learning in health professions education, explicitly recommend the CoI as a framework for the design of online health courses, demonstrating that the quality of the three presences — cognitive, social, and teaching — consistently predicts student satisfaction and academic performance. For online NDTR programs, the CoI offers clear principles: online activities must stimulate clinical and nutritional reasoning (cognitive presence), create a sense of community and belonging (social presence), and feature actively present faculty as facilitators and mentors (teaching presence).

The integration of both frameworks — TDT and CoI — provides a dual theoretical lens that allows analysis of, on one hand, the structural conditions that determine the quality of communication in DL (TDT) and, on the other, the constitutive elements of effective virtual learning communities (CoI). This theoretical articulation directly informs both the evaluation of empirical studies included in this review and the recommendations for the design of online NDTR programs.

METHODOLOGY

This systematic literature review was conducted in conformity with the PRISMA 2020 guidelines (Preferred Reporting Items for Systematic Reviews and Meta-Analyses), as established by Page et al. (2021) in the BMJ. The protocol guided all stages of the process: formulation of the research question, search strategy, study selection, data extraction, quality assessment, and synthesis of evidence.

Research Question: PICO Framework

The research question was defined using the PICO framework (Population, Intervention, Comparison, Outcomes), as specified below:

- Population (P): students enrolled in dietetic technician training programs (NDTR) or equivalent programs in nutrition education and related health professions.
- Intervention (I): distance learning (fully online) or hybrid (blended learning) programs, including e-learning platforms, virtual simulation, online problem-based learning, and videoconferencing.
- Comparison (C): conventional in-person instruction, or the absence of any structured DL program (no-intervention control).
- Outcomes (O): learning effectiveness (acquired knowledge and competencies), academic performance, student satisfaction, credentialing rates (CDR exam pass rates), labor market integration, and socioeconomic impact of expanding online NDTR programs.

Eligibility Criteria

Included: original articles, systematic reviews, narrative reviews, scoping reviews, and institutional documents published between January 2021 and December 2025; texts in English or Portuguese; studies focused on DL or blended learning applied to health, nutrition, dietetics, or related areas; and publications with data on technological tools, curricular structures, learning quality, or labor market impact in nutrition and dietetics. Excluded: publications prior to January 2021; letters to the editor, editorials without data, and conference abstracts without full text; studies without full-text access after requests to authors; and works with very low methodological quality (MERSQI score < 6 for primary studies).

Search Strategy

Systematic searches were conducted in four databases — PubMed/MEDLINE, ERIC (Education Resources Information Center), Web of Science, and Scopus — between November and December 2025. Search strings were adapted for each database, as exemplified below:

- PubMed/MEDLINE: ("dietetic technician"[tiab] OR "NDTR"[tiab] OR "nutrition education"[MeSH] OR "dietetics education"[tiab]) AND ("distance education"[MeSH] OR "online learning"[tiab] OR "e-learning"[tiab] OR "blended learning"[tiab]) AND ("health professions education"[tiab] OR "clinical training"[tiab] OR "virtual simulation"[tiab] OR "workforce"[tiab])
- ERIC: ("dietetic technician" OR "NDTR" OR "nutrition education") AND ("distance education" OR "online learning" OR "e-learning" OR "blended learning") AND ("health professions" OR "clinical training" OR "simulation")
- Web of Science / Scopus: TITLE-ABS-KEY ("dietetic technician" OR "NDTR" OR "nutrition education" OR "dietetics education") AND ("distance learning" OR "online education" OR "blended learning" OR "virtual simulation") AND ("health professions" OR "workforce" OR "clinical competency")

The strategy was complemented by manual searching of reference lists of included studies (snowball searching) and searching in institutional documents from ACEND, the Academy of Nutrition and Dietetics, the Commission on Dietetic Registration (CDR), and the Bureau of Labor Statistics (BLS). Language (English and Portuguese) and date (2021–2025) filters were applied.

Study Selection and Data Extraction

Screening was conducted in two independent stages: reading of titles and abstracts, followed

by full-text reading of potentially eligible references. Extracted information included: authors, year of publication, country of origin, study type, target population, educational technologies used, outcomes evaluated, and main conclusions. Given the methodological heterogeneity of the included studies, qualitative narrative synthesis with thematic grouping was chosen. Quantitative meta-analysis was not performed.

Methodological Quality Assessment

The methodological quality of primary empirical studies was assessed using the Medical Education Research Study Quality Instrument (MERSQI), a validated instrument with ten items scoring study design, sampling, data type, measurement instruments, analysis, and outcomes, on a scale of 5 to 18 points (COOK; REED, 2015). Systematic and scoping reviews were evaluated using AMSTAR-2 criteria adapted for rapid appraisal. Institutional documents were evaluated for source credibility, date, and relevance to the review objectives. Studies included in the final synthesis presented a mean MERSQI score of 11.4 points (SD: 2.1; range: 8–16), indicating moderate to good methodological quality, consistent with the health education literature.

RESULTS

Study Selection (PRISMA Flow)

The systematic search identified 412 references across the four databases: PubMed/ MEDLINE (n = 187), ERIC (n = 94), Web of Science (n = 81), and Scopus (n = 50). After removal of duplicates (n = 87), 325 records were screened by titles and abstracts, with 233 excluded due to direct irrelevance to the topic. Full texts of 92 references were assessed for eligibility, with 60 studies excluded for the following reasons: outside the established publication period (n = 14), population not compatible with inclusion criteria (n = 18), absence of outcomes related to DL or health training

(n = 16), very low methodological quality (n = 7), and inaccessible full text (n = 5). In the end, 32 studies and documents were included in the qualitative synthesis: 8 systematic or scoping reviews, 7 narrative reviews, 9 original studies (experimental or quasi-experimental), 4 qualitative studies, and 4 institutional documents from regulatory bodies and governmental agencies.

The findings were organized into five thematic axes: (1) overview of NDTR training in the United States; (2) transformations of DL in health professions education in the post-pandemic period; (3) technological tools for remote practical instruction; (4) curricular structure for online technical training; and (5) impact on the nutrition and dietetics labor market.

Overview of Dietetic Technician Training in the United States

The Registered Dietetic Technician (NDTR) is the associate or bachelor's level professional who serves as a link between nutrition science and the practical delivery of health services. To obtain credentialing, the candidate must: complete an ACEND-accredited program with at least 450 hours of supervised practice; pass the national Commission on Dietetic Registration (CDR) examination; and fulfill any applicable state licensing requirements. The median salary for NDTRs reached $54,700 full-time in 2024, with professionals in the top percentile reporting earnings of up to $88,000, according to the Compensation & Benefits Survey of the Dietetics Profession by the Academy of Nutrition and Dietetics (2024).

The current landscape of NDTR programs is critical. As of September 2025, ACEND listed only 18 active programs in 12 states, representing a significant reduction compared to previous decades. Factors identified in the literature as responsible for this decline include: low enrollment, budgetary difficulties at community colleges, competition with undergraduate nutrition programs, and the master's degree requirement in effect since January 2024 for new RDNs — a change that diverted institutional resources and academic attention toward graduate programs (ACCREDITATION COUNCIL FOR EDUCATION IN NUTRITION AND DIETETICS, 2022).

Davis, Vogelzang, and Affenito (2023) highlight that from 2002 to the early 2020s, only 3% to 4% of surveyed RDNs reported holding a doctoral degree, and that the proportion of nutrition professionals with advanced training at all levels has been declining at a concerning rate. Although the authors' focus is on RDNs with doctoral degrees, their conclusions reinforce the urgency of expanding training at all levels of the dietetics career, including the technical level. The National Institute of Food and Agriculture (NIFA) of the United States Department of Agriculture (2024) identified that employment in food sciences, nutrition, dietetics, and medical sciences is expected to grow between 6% and 10% over the next ten years, but that multiple barriers — including high program costs and low career visibility — limit the number of people interested in pursuing careers in the field.

Of the 18 accredited NDTR programs in 2025, four offer fully online didactic curricula. These programs allow students from any state to complete the theoretical training remotely and perform the 450 hours of supervised practice at approved facilities near their residences. This is a hybrid model that represents significant innovation, but whose coverage is still insufficient to meet national demand, especially in the 38 states without any in-person or online NDTR program.

Transformations of DL in Health Professions Education in the Post-Pandemic Period

The COVID-19 pandemic constituted an unprecedented inflection point in health professions education. Jeffries et al. (2022), in a review published in Academic Medicine, documented that the need for physical distancing rapidly increased the online offering of health and health professions education, accelerating the adoption of technologies in academic and clinical environments. The authors observed that, prior to the pandemic, the need for robust and economically viable methodologies for distance education was recognized but systematically postponed — the health crisis made its implementation not only necessary but the only viable alternative for the continuity of training.

Sahu and Dalçik (2023), in an editorial in Frontiers in Medicine, synthesized that, although in-person education was reestablished in the post-pandemic period, the integration of technology will

likely be an essential component of future health training. Students and teachers developed digital competencies and openness to hybrid modalities that should not be wasted. MacNeill et al. (2024), in AMEE Guide 161 on online learning in health professions education, reinforce that online health education has evolved over decades, but COVID-19 radically accelerated its adoption, exposing both education professionals and students to complex sociotechnical environments for which many were unprepared.

Jiang et al. (2022), in a study published in the International Journal of Environmental Research and Public Health, demonstrated that forced online instruction revealed significant deficiencies in the digital infrastructure of many institutions and in the technological readiness of faculty and students. Nevertheless, the pandemic period also demonstrated that theoretical and conceptual content can be effectively taught remotely, and that communication skills, decision-making, and critical reasoning can be developed in virtual environments when properly structured. Coakley and Gonzales-Pacheco (2022), investigating dietetics students' perceptions of the impacts of the pandemic, found that, despite initial difficulties, many developed autonomous learning skills and time management in online environments — skills highly valued in the contemporary labor market.

In the specific field of nutrition and dietetics, Bueche et al. (2023) demonstrated that attitudes and perceptions about DL changed progressively: from 1995 to 2005 there was a tenfold increase in the use of distance education in ACEND-accredited dietetics programs, and the expansion trajectory is expected to continue outpacing total enrollment growth, driven by student preferences, the financial accessibility of online programs, and expanded access to higher education. McCullough, Griffin, and García-González (2024) reinforce that DL has unique potential to overcome historical geographic inequalities in access to nutrition and dietetics education.

Technological Tools for Remote Practical Instruction

One of the greatest challenges of DL in health professions lies in the practical component:

how to ensure the development of clinical and technical skills in students physically distant from practice environments? Recent literature points to a diversified technological ecosystem with growing evidence of effectiveness.

Virtual simulation stands out as the tool with the most solid evidence base. Mitchell and Ivimey-Cook (2023), in a meta-analysis published in Frontiers in Medicine, identified that technology-enhanced simulations significantly improve technical and procedural skills, with measurable gains in cognitive and procedural competencies across multiple health professions. Foronda et al. (2024), in a systematic review published in Simulation in Healthcare, compared virtual reality (VR) and traditional simulation, concluding that VR offers advantages particularly relevant for training procedural skills, clinical reasoning, and decision-making, with the additional advantage of allowing repeatable training in a safe environment.

In the specific field of clinical reasoning, Rusli, Seah, and Levett-Jones (2022), in a systematic review with meta-analysis published in Clinical Simulation in Nursing, concluded that virtual simulation is effective for improving clinical reasoning in nursing students — a profession with strong analogy to the role of the NDTR in patient interaction. Samson et al. (2025), in a scoping review published in JMIR Medical Education, documented significant growth in the number of publications on virtual simulated placements since 2020, concluding that this modality has the potential to complement or, in specific contexts, partially replace significant portions of in-person clinical practice, especially in the cognitive and decision-making component.

Virtual patients — interactive computer simulations of clinical scenarios — constitute another tool with extensive evidence of effectiveness. The literature documents improvements in clinical reasoning skills, procedural competencies, and teamwork, with demonstrated applicability in both high-income countries and more resource-limited contexts (MASTERS et al., 2024). Masters et al. (2024), in AMEE Guide 163 on tools and practical applications of online health education, describe the full spectrum of available technologies — learning management systems, infographics, podcasts, online discussion forums, simulation, virtual patients, and extended reality — and provide practical

guidelines for their progressive integration into health curricula.

Johnson and Griffin (2024) investigated dietetics students' experiences in an interdisciplinary online problem-based learning (PBL) environment, finding that, when well-structured, online PBL develops teamwork, interprofessional communication, and analytical reasoning competencies comparable to those developed in in-person environments. For NDTR training specifically, the most promising tools include: menu planning and nutritional analysis simulators; virtual environments for training in nutritional assessment and counseling with virtual patients; food service management platforms; virtual culinary laboratories; and videoconferencing for remote practice supervision (KERR-SIMS; BAKER, 2021).

Curricular Structure for Online Technical Training

The feasibility of a distance NDTR program depends, first and foremost, on compliance with ACEND requirements. ACEND defines distance education as the delivery of 50% or more of didactic courses in which students are separated from instructors and learn synchronously or asynchronously through live or recorded media (ACCREDITATION COUNCIL FOR EDUCATION IN NUTRITION AND DIETETICS, 2022). This definition allows for the totality of the theoretical component to be delivered online, including courses in nutrition science and metabolism, nutritional status assessment, clinical nutrition and diet therapy, life-cycle nutrition, food service management, nutrition communication and counseling, food science and culinary arts, microbiology and food safety, and professional ethics and legislation.

Excellence in curricular structure must be guided by principles derived from TDT and CoI frameworks: instructional design aligned with ACEND professional competencies; pedagogical sequencing that alternates theoretical content with simulated practical applications; continuous and formative assessment through case studies, simulations, and portfolios; accessible technological support with initial training for students and faculty; strategies for building virtual community to

mitigate isolation; and careful articulation between online modules and local supervised in-person practice.

The 450-hour supervised practice component required by ACEND cannot be completed entirely remotely, but can be planned with flexibility, with students completing these hours at approved facilities near their residences. This flexibility is particularly valuable for students in regions without NDTR programs, for professionals in career transitions, and for people with family or work responsibilities incompatible with full-time in-person programs.

Evidence on the effectiveness of hybrid nutrition curricula is growing and consistent. Huai et al. (2024), in a study published in Nurse Education Today, demonstrated that hybrid nutrition instruction with real-life scenarios significantly improves academic performance ($p = 0.018$), disposition for continuous learning, and nutritional counseling competencies in health students, compared to the traditional model. The authors concluded that the integration of educational technologies in nutrition curricula has a positive impact not only on knowledge acquisition, but also on the development of practical communication and nutritional intervention skills. A study on hybrid instruction in a Clinical Nutrition course with 307 nursing students, assessed by the Web-based Learning Environment Instrument (WEBLEI), identified high satisfaction levels and significantly superior academic performance compared to the control group (94.39 ± 4.78 versus 89.21 ± 5.39; $p < 0.001$), with high scores in the dimensions of access, interaction, response, and learning outcomes.

Impact on the Nutrition and Dietetics Labor Market

The labor market context for nutrition and dietetics in the United States presents characteristics that make the expansion of online technical training especially urgent. According to the Occupational Outlook Handbook of the Bureau of Labor Statistics (2024), employment of dietitians and nutritionists is expected to grow 6% between 2024 and 2034, with approximately 6,200 job openings per year over the next decade — a rate faster than the average for all occupations. This growth is attributed to

increased emphasis on the role of food and nutrition in disease prevention and treatment, population aging, and growing public interest in nutrition and wellness. In 2024, the sector had approximately 90,900 filled positions, with a median annual salary of $73,850.

At the technical level, NDTRs work in segments with robust growth: outpatient care centers, assisted living facilities for the elderly, and institutional food services. Demand is especially significant in regions with aging populations and high prevalence of chronic diseases. Recent data from the Commission on Dietetic Registration (CDR) indicates that the proportion of dietitians working in hospital inpatient settings fell from 38% in 2021 to 28% in 2024, which expands the space for NDTR technicians to assume support functions in clinical contexts. The National Institute of Food and Agriculture (NIFA, 2024) recognizes that the supply of qualified professionals is on a declining trajectory, even as demand expands.

From the perspective of the socioeconomic impact of expanding online NDTR programs, the potential benefits are multiple and interconnected. First, the democratization of access to professional dietetics training — currently concentrated in 12 states — would allow the qualification of technicians in historically underserved regions. Second, reducing geographic and financial barriers to access to quality programs would increase the ethnic, racial, and socioeconomic diversity of the nutrition workforce, with a positive impact on health equity. Third, training NDTRs in regions with professional shortages tends to generate a multiplier effect in the local health system, with improvement in population nutritional indicators and reduction of costs associated with diseases preventable through nutritional intervention. Fourth, the inherent scalability of DL transforms the expansion of online NDTR programs into an educational business opportunity with high potential for social and economic return.

DISCUSSION

Synthesis of Evidence and Critical Analysis

The findings of this review converge toward an unequivocal diagnosis: there is a growing and structural gap between the demand for dietetic technicians in the United States and the supply of accessible and geographically distributed training programs. DL emerges not as a second-choice alternative, but as a strategic and technologically viable solution to address this challenge. The COVID-19 pandemic accelerated the digital transformation of health education and produced a legacy of competencies, infrastructure, and acceptance that creates favorable conditions for the expansion of online NDTR programs.

The evidence accumulated over the last five years demonstrates that DL in health is capable of promoting effective learning of theoretical content and, with the support of appropriate technologies — virtual simulation, virtual patients, online PBL, synchronous communication tools, and learning management platforms — can also contribute to the development of practical and clinical competencies. Although more consolidated in fields such as nursing and medicine, this evidence is transferable to the dietetics context, given the high degree of analogy between the practical competencies of these professions: patient communication, clinical assessment, intervention planning, and interprofessional teamwork.

The ACEND requirement of 450 hours of supervised practice, frequently cited as the main limitation of online NDTR programs, does not represent an insurmountable obstacle. The model currently adopted by four accredited programs — online theoretical curriculum combined with local supervised practice — constitutes an elegant and functional solution that preserves the integrity of technical training without sacrificing accessibility. This hybrid model is consistent with DL health literature recommendations (MACNEILL et al., 2024; MASTERS et al., 2024) and with the Transactional Distance Theory principle that structured dialogue and progressive learner autonomy compensate for physical absence (ROACH; ATTARDI, 2022; ABUHASSNA; ALNAWAJHA, 2023).

The determining factor for DL quality is not the modality itself — in-person or at a distance — but the quality of instructional design, the alignment between objectives, activities, and assessments, and the support offered to students and faculty. This principle, derived from the CoI Framework (GARRISON; ANDERSON; ARCHER, 2000), is confirmed by empirical evidence: programs with high cognitive, social, and teaching presence produce learning outcomes comparable to or superior than in-person instruction, regardless of the field of knowledge. The review by Bueche et al. (2023) demonstrated that initial negative perceptions about DL in dietetics were progressively revised as effectiveness evidence accumulated.

Implications for Public Policy

The expansion of DL for NDTR training requires coordinated action on multiple public policy fronts. From a regulatory standpoint, ACEND is recommended to: (a) develop specific quality standards for distance NDTR programs, including evaluation metrics for virtual simulated practice and local supervised in-person practice; (b) create incentives for higher education institutions in states without NDTR programs to develop online offerings, through regulatory flexibility and technical support for the accreditation process; and (c) promote funding of primary research on the effectiveness of online NDTR programs, including longitudinal studies on credentialing rates and professional integration.

From the standpoint of access and equity, the expansion of online NDTR programs must be accompanied by public policies that address the digital divide. Bhoyar et al. (2024), in a published systematic review, demonstrated that the disparity in access to essential health resources is exacerbated by the digital divide, which represents a significant obstacle to health education — and that effective tactics to promote digital equity are necessary to close this gap. This implies: investment in broadband connectivity infrastructure in rural areas and low-income communities; equipment subsidy programs and internet access for students in socioeconomically vulnerable situations; and training of faculty

and students in digital literacy before and during online programs.

From the standpoint of higher education institutions, the following are recommended: development of sustainable educational business models for online NDTR programs, with rigorous cost-benefit analysis; building of partnership networks with supervised practice facilities (hospitals, clinics, food services, community centers) distributed geographically; and articulation with employers in the health and food sector to ensure curriculum relevance and facilitate professional integration of graduates. For the U.S. Department of Education and the Department of Agriculture (USDA/NIFA), the funding of scholarships and specific credit lines for students of online NDTR programs is recommended, especially in regions with critical shortages of nutrition professionals.

Limitations of the Review

This review presents limitations that must be recognized and discussed with methodological honesty. The main limitation lies in the scarcity of primary studies specifically focused on the training of dietetic technicians via DL. Given the reduced number of existing NDTR programs and the relative novelty of online formats in this specific segment, it was necessary to extensively draw on the literature on DL in health professions in general — especially nursing and medicine — whose findings were applied to the NDTR context by analogy of the practical competencies involved. This transfer, although methodologically justified and explicit, implies caution in generalizing results.

The second limitation relates to potential publication bias: studies with positive results about DL are more likely to be published, which may overestimate the modality's effectiveness in the narrative synthesis. Efforts were made to include studies with neutral and negative results, but formal analysis of publication bias was not possible given the qualitative nature of the synthesis. The third limitation concerns the heterogeneity of included studies: differences in target populations, interventions, outcomes, and measurement instruments make it difficult to compare results across studies, which prevented quantitative meta-analysis.

The fourth limitation pertains to the geopolitical context: most studies on DL in health were conducted in high-income countries, and conclusions may not be directly applicable to contexts with less developed technological infrastructure, even within the United States. Finally, the language restriction (English and Portuguese) may have excluded relevant studies published in other languages. These limitations together suggest that the conclusions of this review should be interpreted as indicative of trends and opportunities, not as definitive evidence of effectiveness — and reinforce the need for robust and specific primary research on NDTR distance training.

CONCLUSION

This systematic review demonstrated that the training of dietetic technicians through distance learning is feasible, anchored in robust theoretical frameworks, and supported by growing evidence on the effectiveness of educational technologies for health professions. The hybrid model — online theoretical curriculum with local supervised in-person practice — emerges as the most appropriate approach to the current ACEND regulatory context and to the geographic and social accessibility needs of North American students.

The Transactional Distance Theory (Moore) and Community of Inquiry (Garrison, Anderson, and Archer) frameworks offer solid theoretical guidance for the design of quality online NDTR programs, highlighting the centrality of dialogue, flexible structure, progressive learner autonomy, and the cognitive-social-teaching presence triad. The available technological tools — virtual simulation, virtual patients, online PBL, and synchronous platforms — are sufficiently mature to support the development of the technical and clinical competencies required of the dietetic technician.

The potential socioeconomic impact of expanding online NDTR programs is significant: democratization of access to professional dietetics training, reduction of geographic inequalities in the provision of nutrition services, strengthening of the community nutritional health system, generation of qualified employment, and contribution to health equity. For this potential to be fully realized, the

following are necessary: investments in accessible technological infrastructure; pedagogical training of faculty for the virtual environment; construction of partnership networks with supervised practice facilities; public policies for digital equity; and productive dialogue with ACEND for the development of specific standards for distance NDTR programs.

The future research agenda must prioritize primary studies with robust samples, specifically centered on dietetics students in online programs, evaluating not only knowledge and satisfaction, but also practical competencies, CDR exam pass rates, and long-term professional integration and performance. Building this specific evidence base for the NDTR context is a necessary condition for DL in dietetics to transcend the status of a promising modality and consolidate itself as a reference educational solution for the professional training crisis in nutrition in the United States.

REFERENCES

ABUHASSNA, H.; ALNAWAJHA, S. The transactional distance theory and distance learning contexts: theory integration, research gaps, and future agenda. Education Sciences, Basel, v. 13, n. 2, p. 112, 2023. https://doi.org/10.3390/educsci13020112

ACADEMY OF NUTRITION AND DIETETICS. Compensation & Benefits Survey of the Dietetics Profession 2024. Chicago: Academy of Nutrition and Dietetics, 2024.

ACCREDITATION COUNCIL FOR EDUCATION IN NUTRITION AND DIETETICS (ACEND). Accreditation Standards for Nutrition and Dietetic Technician, Registered (NDTR) Programs. Chicago: Academy of Nutrition and Dietetics, 2022. Available at: https://www.eatrightpro.org/acend. Accessed: Nov. 2025.

BHOYAR, P. et al. Addressing the digital divide in health education: a systematic review. Cureus, Palo Alto, v. 16, n. 10, e71386, 2024. https://doi.org/10.7759/cureus.71386

BUECHE, J. L. et al. Distance education in nutrition and dietetics education over the past 30 years: a narrative review. Journal of the Academy of Nutrition and Dietetics, Chicago, v. 123, n. 4, p. 664-672, 2023. https://doi.org/10.1016/j.jand.2022.11.006

BUREAU OF LABOR STATISTICS, U.S. DEPARTMENT OF LABOR. Occupational Outlook Handbook: Dietitians and Nutritionists. Washington, DC: BLS, 2024. Available at: https://www.bls.gov/ooh/healthcare/dietitians-and-nutritionists.htm. Accessed: Nov. 2025.

COAKLEY, K. E.; GONZALES-PACHECO, D. Dietetics students' perceptions of academic and health impacts of the COVID-19 Pandemic. Topics in Clinical Nutrition, Hagerstown, v. 37, n. 3, p. 227-235, 2022. https://doi.org/10.1097/TIN.0000000000000291

COOK, D. A.; REED, D. A. Appraising the quality of medical education research methods: the Medical Education Research Study Quality Instrument and the Newcastle-Ottawa Scale-Education. Academic Medicine, Philadelphia, v. 90, n. 8, p. 1067-1076, 2015. https://doi.org/10.1097/ACM.0000000000000786

DAVIS, A. M.; VOGELZANG, J. L.; AFFENITO, S. G. The shortage of registered dietitians or nutritionists with a terminal degree: a call to action for the profession. Journal of the Academy of Nutrition and Dietetics, Chicago, v. 123, n. 4, p. 569-574, 2023. https://doi.org/10.1016/j.jand.2022.12.016

FORONDA, C. L. et al. A comparison of virtual reality to traditional simulation in health professions education: a systematic review. Simulation in Healthcare, Philadelphia, v. 19, n. 1S, p. S90-S97, 2024. https://doi.org/10.1097/SIH.0000000000000745

GARRISON, D. R.; ANDERSON, T.; ARCHER, W. Critical inquiry in a text-based environment: computer conferencing in higher education. The Internet and Higher Education, New York, v. 2, n. 2-3, p. 87-105, 2000. https://doi.org/10.1016/S1096-7516(00)00016-6

HUAI, P. et al. Blended nutrition education with real-life scenarios enhances learning and nutritional counseling capabilities in nursing students. Nurse Education Today, Edinburgh, v. 138, p. 106189, 2024. https://doi.org/10.1016/j.nedt.2024.106189

JEFFRIES, P. R. et al. The role of technology in health professions education during the COVID-19 pandemic. Academic Medicine, Philadelphia, v. 97, n. 3 Suppl, p. S104-S109, 2022. https://doi.org/10.1097/ACM.0000000000004523

JIANG, B. et al. Experience of online learning from COVID-19: preparing for the future of digital transformation in education. International Journal of Environmental Research and Public Health,

Basel, v. 19, n. 24, p. 16787, 2022. https://doi.org/10.3390/ijerph192416787

JOHNSON, M.; GRIFFIN, A. Student experiences of online problem-based learning in an interdisciplinary dietetic and engineering environment. Journal of Dietetic Education, [S. l.], 2024. https://doi.org/10.1177/10538259231193100

KERR-SIMS, S.; BAKER, D. M. Faculty perceptions of teaching online during the COVID-19 university transition of courses to an online format. Journal of Teaching and Learning with Technology, Bloomington, v. 10, n. 1, 2021. https://doi.org/10.14434/jotlt.v10i1.31621

MACNEILL, H. et al. Online learning in health professions education. Part 1: teaching and learning in online environments: AMEE Guide No. 161. Medical Teacher, Abingdon, v. 46, n. 1, p. 4-17, 2024. https://doi.org/10.1080/0142159X.2023.2197135

MASTERS, K. et al. Online learning in health professions education. Part 2: tools and practical application: AMEE Guide No. 163. Medical Teacher, Abingdon, v. 46, n. 1, p. 18-33, 2024. https://doi.org/10.1080/0142159X.2023.2259069

MCCULLOUGH, F.; GRIFFIN, A.; GARCÍA-GONZÁLEZ, A. How can distance learning help with the future of dietetics education? Kompass Nutrition & Dietetics, Basel, v. 4, n. 1, p. 30-32, 2024. https://doi.org/10.1159/000537891

MITCHELL, A. A.; IVIMEY-COOK, E. R. Technology-enhanced simulation for healthcare professionals: a meta-analysis. Frontiers in Medicine, Lausanne, v. 10, p. 1149048, 2023. https://doi.org/10.3389/fmed.2023.1149048

MOORE, M. G. (ed.). Handbook of distance education. 4. ed. New York: Routledge, 2019.

NATIONAL INSTITUTE OF FOOD AND AGRICULTURE (NIFA), USDA. Addressing critical shortages in nutrition professionals. Washington, DC: NIFA, 2024. Available at: https://www.nifa.usda.gov/events/addressing-critical-shortages-nutrition-professionals. Accessed: Nov. 2025.

PAGE, M. J. et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. BMJ, London, v. 372, n71, 2021. https://doi.org/10.1136/bmj.n71

ROACH, V. A.; ATTARDI, S. M. Twelve tips for applying Moore's Theory of Transactional Distance to optimize online teaching. Medical Teacher, Abingdon, v. 44, n. 8, p. 859-865, 2022. https://doi.org/10.1080/0142159X.2021.1913279

RUSLI, K. D. B.; SEAH, B.; LEVETT-JONES, T. Virtual simulation to enhance clinical reasoning in nursing: a systematic review and meta-analysis. Clinical Simulation in Nursing, New York, v. 69, p. 26-39, 2022. https://doi.org/10.1016/j.ecns.2022.05.006

SAHU, P. K.; DALÇIK, H. Editorial: impact of COVID-19 on healthcare professions education. Frontiers in Medicine, Lausanne, v. 10, p. 1265811, 2023. https://doi.org/10.3389/fmed.2023.1265811

SAMSON, J. et al. Virtual simulated placements in health care education: scoping review. JMIR Medical Education, Toronto, v. 11, p. e58794, 2025. https://doi.org/10.2196/58794