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RESEARCH ARTICLE

Diet and Physical Activity Prevention Research Supported by the U.S. NIH From 2012–2017

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Introduction: Poor diet and inadequate physical activity are common contributors to preventable death in the U.S. This paper provides a summary of the NIH-sponsored research on disease prevention that underlies public health and clinical recommendations to improve diet and physical activity.

Methods: A representative sample (n=11,082) of research grants and cooperative agreements (research projects) representing the NIH prevention research portfolio between 2012 and 2017 were hand coded by trained analysts in 2017–2018. This manuscript describes the rationale(s), exposure(s), outcome(s), population(s), and study design(s) in prevention research focused on diet and physical activity and compares this research to identified research gaps in the field.

Results: A relatively stable 7.8% (95% CI=7.0%, 8.8%) and 5.0% (95% CI=4.4%, 5.7%) of the NIH prevention research projects were focused on diet and physical activity, respectively, during 2012–2017. These projects often explored diet and physical activity together in the context of obesity, included observational studies, and focused on a general adult population. Few of these projects focused on development of improved assessment methods. Approximately 50% of these studies were related to research gaps identified by the 2015 Dietary or 2018 Physical Activity Guidelines Advisory Committee Scientific Reports.

Conclusions: Opportunities exist for more engagement by NIH and scientific investigators in diet- and physical activity–focused prevention research, particularly around assessment and known research gaps.

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INTRODUCTION

Poor diet and inadequate levels of physical activity are leading risk factors for death in the U.S.[1] Clinical and public health advances that improve diet and physical activity could prevent cancer and cardiovascular, metabolic, and many other diseases that shorten American lifespans.[1–5] The U.S. NIH is the largest funder of the biomedical research that serves as the evidence base for disease prevention and health promotion.[6]

Most (>80%)[7] of the NIH budget is distributed to academic and other researchers through the scientific peer-review system, and the results of this research have contributed to significant advances in health through diet- and physical activity–related research. For example, diabetes is a leading cause of death in the U.S.,[8] and NIH-funded researchers developed the Diabetes Prevention Program RCT,[9–11] which demonstrated that weight loss through diet and physical activity reduced the risk of developing diabetes. Subsequently, NIH and the U.S. Centers for Disease Control and Prevention, through the National Diabetes Prevention Program, have supported

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research to evaluate national implementation across many venues. The joint evidence base supported by NIH and the Centers for Disease Control and Prevention efforts was utilized by the Centers for Medicare and Medicaid Services in enacting its 2018 reimbursement policy for such programs. Though much research serves as the basis for future research, characterizing the landscape of recently funded nutrition and physical activity research provides insights for future research directions on interventions that can ultimately be translated for public health use.

In the most recent NIH Nutrition Research Report, 5% of total NIH research funding (>$1.5 billion annually) was invested in nutrition research.[12] This report includes all NIH-funded nutrition research, including prevention, but does not provide many quantitative details on the characteristics of the proposed research. No similar federal report exists for physical activity. Other reports or publications that describe NIH-funded research in the areas of nutrition[13,14] or physical activity[15–17] have focused on very specific areas of research and, therefore, have not provided a comprehensive characterization of the funding landscape. Given the impact of diet and physical activity on preventing morbidity and premature mortality in the U.S.,[1] a detailed understanding of NIH prevention research in this space may identify areas for focused future research.

This manuscript describes the rationale(s), exposure(s), outcome(s), population(s), and study designs(s) in NIH-funded prevention research focused on diet and physical activity from fiscal years 2012–2017. Diet and physical activity are in the causal pathway to many of the same diseases and hence are studied together frequently in the same research project. Thus, this manuscript describes the percentage of research projects focused on diet, physical activity, or both. These data will provide a panoramic view of the characteristics of new and ongoing human research across all NIH Institutes, Centers, and Offices that could add to the evidence base for diet and physical activity policies and public health and clinical care guidance. A secondary aim is to evaluate the relevance of this research in addressing major new areas of science and research gaps that were specifically identified by the 2015 Dietary Guidelines Advisory Committee (DGAC)[18] and 2018 Physical Activity Guidelines Advisory Committee (PAGAC) Scientific Reports.[19]

METHODS

Study Sample

The U.S. NIH awarded 64,744 new research projects including grants, subprojects from cooperative agreements, and program projects in fiscal years 2012–2017 to extramural researchers using 12 of the most commonly funded research activity codes (R01, R03, R21, R43, R44, R56, U01, U19, U54, UM1, P01, and P50).[20] These 64,744 projects are equivalent to 58,104 Type 1, 2, or 9 research awards, as some awards have multiple projects. Manually reviewing all of these research projects was not feasible; thus, a machine learning tool was applied to predict which research projects were likely prevention focused.[21] After obtaining predictions for each research project, the authors manually coded a representative sample of projects (n=11,082) predicted to be prevention and those not predicted to be prevention (70.3% sensitivity, 91.1% specificity).[22] A team of 3 research analysts independently read and coded each research project's title, abstract, and public health relevance statement to identify all rationale(s), exposure(s), outcome(s), population(s), and study design(s). Therefore, multiple coding selections were possible for a given research project. Murray et al.[22] describes the coding process in more detail.

Measures

This manuscript describes a subset of the entire NIH Prevention Research Portfolio presented by Murray and colleagues[22] that was focused on diet, physical activity, or both. Specifically, prevention research was defined as primary or secondary prevention research in humans (which includes, for example, weight loss studies) and related methods development.[22] Diet- or physical activity–focused prevention research projects were identified when diet or physical activity was an exposure or outcome for at least 1 aim of the project. To enumerate research needs that are already being addressed by the scientific community and remaining research gaps, research projects were compared with areas of research need identified in the 2015 DGAC[18] and 2018 PAGAC Scientific Reports.[19] Specifically, 2 research analysts independently reviewed the "Needs for Future Research" section of these documents and coded the research projects using the title, abstract, and public health relevance statement. For the DGAC Scientific Report, 29 research areas relevant to both prevention and the NIH mission[23] were identified; the diet-focused prevention research projects were coded according to these areas. For the PAGAC Scientific Report, the physical activity research projects were coded according to the 6 overarching research needs or the 93 unique research needs identified within the 11 chapters in the Report. Of all research projects coded, 10% were reviewed independently to ensure the accuracy of the coding.

Statistical Analysis

A total of 11,082 randomly selected, representative research projects were manually coded and then extrapolated up to the total number of 64,744 research projects using Stata/SE, version 15. Of these 11,082 projects, precisely 568 diet- and 390 physical activity–focused were prevention research projects (of which 196 contained both diet- and physical activity–focused prevention research). Extrapolating these 762 coded research projects allowed for estimates on the whole NIH prevention portfolio focused on diet and physical activity presented here. To extrapolate from the coded research projects, weights were calculated for each project within machine learning prediction, award activity code, award type, and fiscal year. Then, the default SVYSET function using pweight and finite population correction options were exercised to calculate point estimates at proportions and 95% CIs. Test for time trends was completed using logistic regression within the SVYSET function, and significance was

determined when 95% CIs did not overlap. Owing to the great variability in total awarded dollars for projects and the observation that the relative percentage of total projects follows the relative percentage of total dollars in analyses, most of the results are reported in percentage of projects. Comparisons can be made within and between the 2 portfolios because this was an a priori aim and methods were developed for this purpose.

RESULTS

After extrapolation, 843 research projects, or 7.8% (95% CI=7.0%, 8.8%) of the NIH prevention research portfolio, were estimated to be focused on diet in fiscal years 2012–2017. This contrasts with an estimated 541 research projects, or 5.0% (95% CI=4.4%, 5.7%) of the NIH prevention research portfolio, that were observed to be focused on physical activity over the same time period. Diet- and physical activity–focused prevention research often co-occurred in an estimated 266 research projects, or a proportion of 2.4% (95% CI=2.1%, 2.7%) of the prevention research portfolio at NIH, indicating approximately a third of all diet-focused prevention research also focused on physical activity and half of all physical activity–focused prevention also focused on diet. There were no significant trends over time for either diet- (p=0.524; Appendix Figure 1a, available online) or physical activity–focused prevention research projects (p=0.389; Appendix Figure 1b, available online). The proportion of prevention research dollars attributable to diet- (6.7%, 95% CI=5.7%, 7.7%) and physical activity–focused research (4.3%, 95% CI=3.7%, 4.8%) were similar to the proportion of research projects; results are presented in research projects throughout the rest of the manuscript.

Principal investigators of diet- and physical activity–focused prevention research projects were more commonly motivated by obesity than any other rationale (diet-focused research: 45.1%, 95% CI=39.4%, 50.9%; physical activity–focused research: 43.5%, 95% CI=37.7%, 49.6%; Table 1). The next most frequent rationales observed in 15%–26% of both diet and physical activity prevention research projects included mortality, heart disease, diabetes, cancer, and stroke. For diet-focused research projects, maternal/paternal/child health (16.4%, 95% CI=13.5%, 19.7%) was also observed frequently. Rationales in 5%–10% of projects varied slightly between the 2 areas; for diet-focused

Table 1. Rationale Behind Diet- or Physical Activity–Focused Prevention Research Funded by NIH from 2012–2017

Rationale topic[a]	Diet-focused prevention research projects (n=843), % (95% CI)[a]	Physical activity-focused prevention research projects (n=541), % (95% CI)[a]
Obesity	45.1 (39.4, 50.9)	43.5 (37.7, 49.6)
Mortality	22.8 (18.4, 28)	26.4 (21.9, 31.4)
Heart disease	22.7 (17.5, 28.7)	20.1 (16.4, 24.4)
Diabetes	21.2 (16.1, 27.3)	17.6 (14.1, 21.8)
Cancer	21.7 (16.6, 27.9)	15.1 (11.8, 19.1)
Stroke	19.4 (14.4, 25.6)	16.7 (13.3, 20.6)
Maternal, paternal, or child health	16.4 (13.5, 19.7)	6.3 (4.4, 9.1)
Mental health	2.2 (1.4, 3.5)	8.4 (3.9, 17.2)
Neurological disease	2.9 (1.9, 4.5)	7.7 (3.3, 16.9)
Unintentional injuries	1.3 (0.7, 2.4)[b]	8.9 (4.3, 17.6)
Infectious disease	7.6 (4.3, 13)	1.5 (0.7, 3)[b]
Musculoskeletal disease	2.7 (1.7, 4.2)	4.2 (2.6, 6.6)
Tobacco	3.1 (2, 4.9)	3.3 (2, 5.5)
Gastrointestinal disease	4.3 (1.6, 11)	0.7 (0.2, 2.2)[b]
Alzheimer's disease	1.3 (0.7, 2.3)	3.3 (2, 5.3)
Kidney disease	2.1 (1.3, 3.5)	2.2 (1.2, 4.1)[b]
Lung disease	2.8 (1.7, 4.4)	1.2 (0.5, 2.9)[b]
Substance abuse	1.6 (0.9, 3)[b]	2.2 (1.1, 4.2)[b]
Alcohol	2.4 (1.4, 4.1)	1.3 (0.6, 3)[b]
Blood disorder	0.4 (0.1, 1)[b]	0.4 (0.1, 2.2)[b]
Pneumonia/influenza	0.2 (0, 1.4)[b]	0.2 (0, 1.1)[b]
Suicide	<0.1[b]	<0.1[b]

[a]Categories are not mutually exclusive, as some research projects contained both diet- and physical activity–focused research and some research projects had more than 1 study rationale.
[b]Indicates < 10 projects were manually coded in this category which may make estimates from these data unstable.

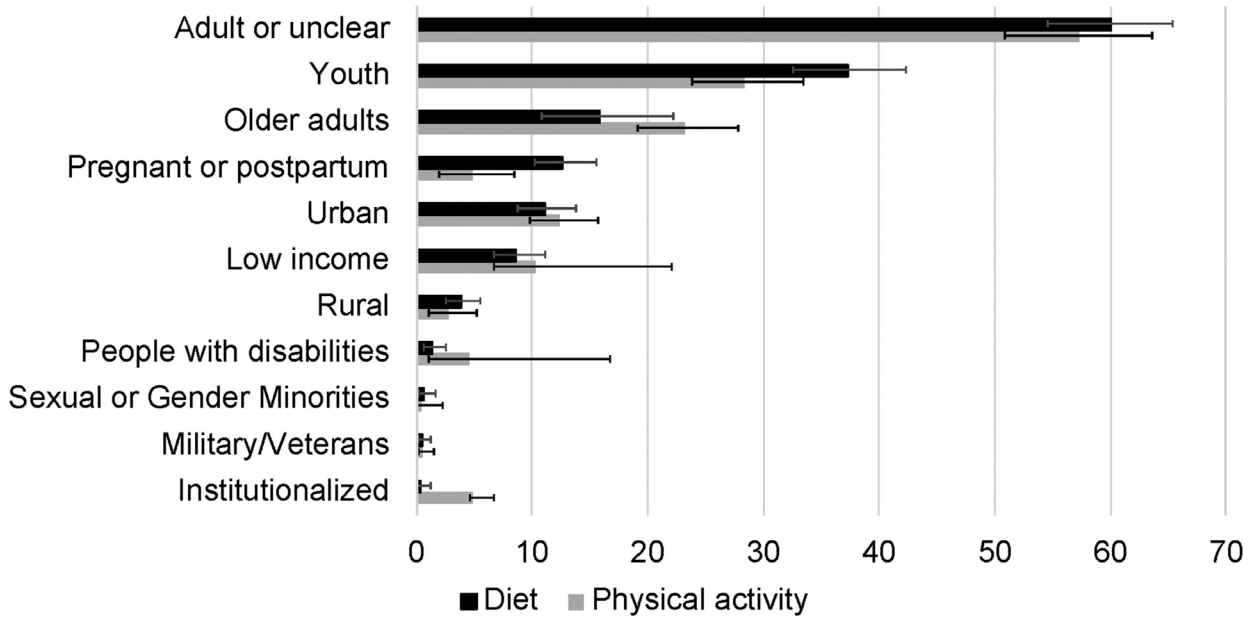


Figure 1. Population(s) in diet- (*n*=843) and physical activity–focused (*n*=541) prevention research supported by NIH from fiscal years 2012–2017.

Note: Data are shown as percentage of prevention research projects and 95% CIs. Categories are not mutually exclusive, as some research projects contained both diet- and physical activity–focused research and some research projects had more than 1 study population. Fewer than 10 projects were manually coded in the following categories, which may make estimates from these data unstable: institutionalized, military/veterans, sexual or gender minorities, and people with disabilities.

research, the only rationale in this range was infectious diseases, whereas for physical activity more rationales were provided in this range (e.g., maternal/paternal/child health, mental health, neurologic health, and unintentional injuries). All other rationales were observed in <5% of projects.

The exposures and outcomes for diet- (Appendix Figure 2a, available online) and physical activity–focused prevention research portfolios (Appendix Figure 2b, available online) were graphed to display which exposure–outcome pairs were studied most often in the same prevention research project. A common network of education/counseling exposures with obesity, diet, and physical activity as outcomes was observed in both portfolios. Genetics was the third most common exposure in diet-focused prevention research but was only the sixth most common exposure in physical activity–focused prevention research. Health-related quality of life was the fourth most common outcome for both portfolios.

Approximately 60% of diet- and physical activity–focused prevention research focused on general adult populations, 30%–40% focused on youth, and 15%–25% focused on older adults (Figure 1). Pregnant or postpartum women were more often studied in diet- (12.6%, 95% CI=10.2%, 15.6%) as opposed to physical activity–focused prevention research (4.9%, 95% CI=3.2%, 7.3%). No additional statistical differences between specific studied populations were observed owing to overlapping CIs. More generally, it was observed that 8%–12% of both diet and physical activity prevention research projects focused on urban or low-income populations, but relatively few projects in either portfolio focused on rural populations or sexual or gender minorities.

For all diet-focused prevention research, nearly half included an observational study (48.3%, 95% CI=42.6%, 54.1%) and >40% included randomized interventions (42.1%, 95% CI=36.3%, 48.1%; Figure 2). More than half of all physical activity–focused prevention research included a randomized intervention design (54.1%, 95% CI=47.6%, 60.4%) and only a third included an observational study design (33.3%, 95% CI=27.2%, 40.0%).

When comparing results between portfolios, these data demonstrate that diet-focused prevention research more often contains observational study designs than does physical activity–focused prevention research. Pilot/feasibility studies were observed in about 16% of both diet- and physical activity–focused research. Collectively, very little research was focused on method development for diet assessment or physical activity assessment.

Overall, 48.0% (95% CI=42.3%, 53.7%) of diet-focused prevention research addressed research areas identified

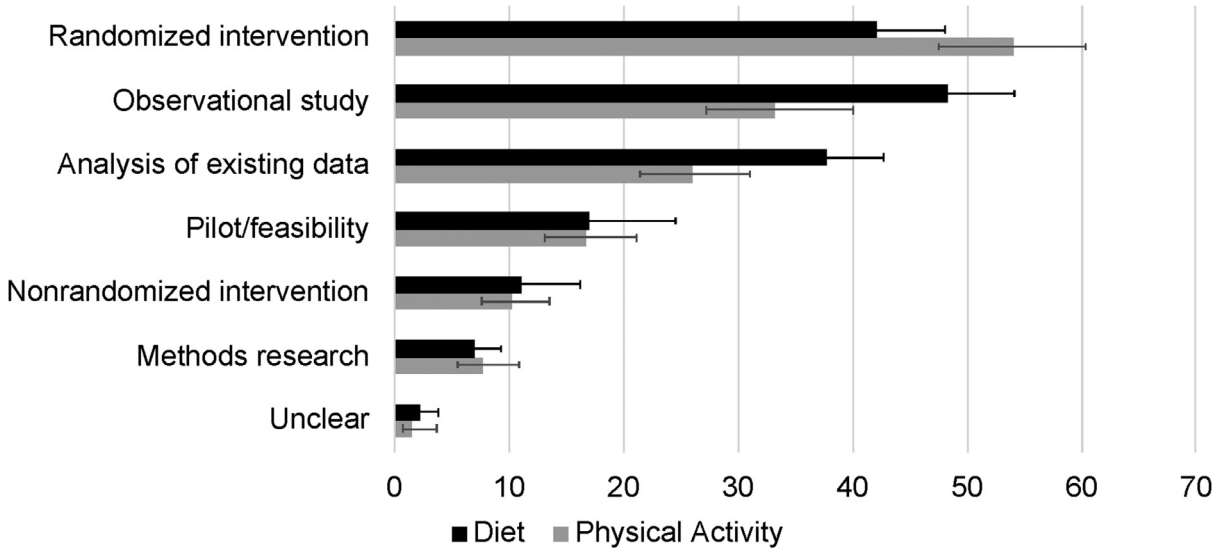


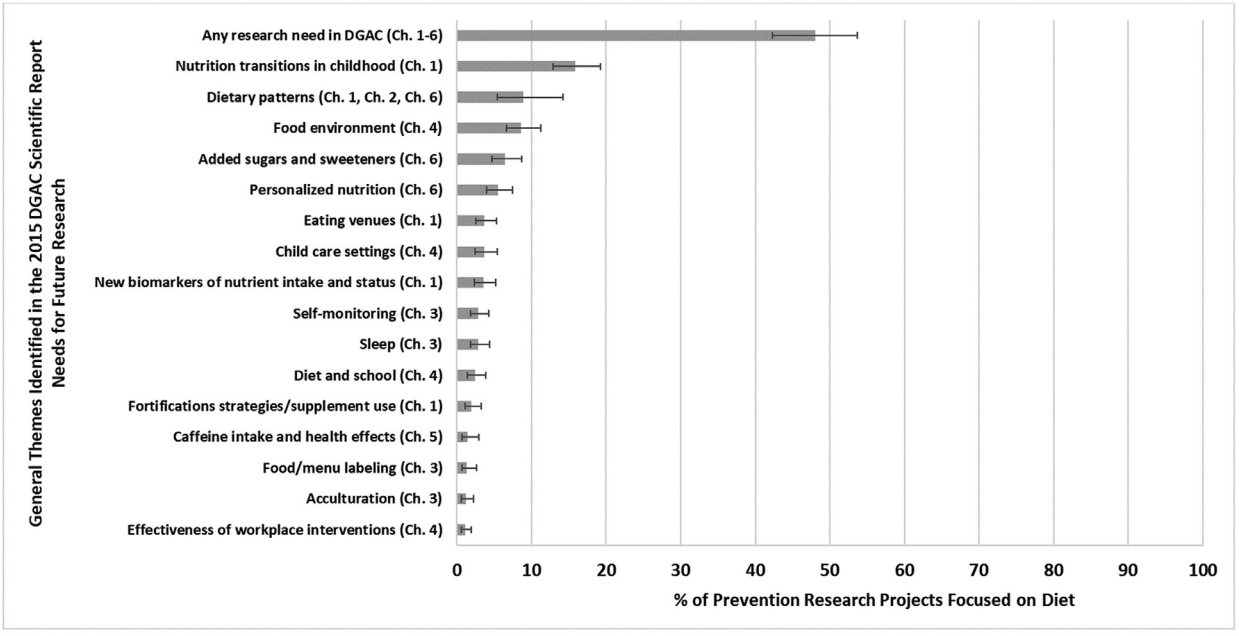
Figure 2. Study design(s) in diet- (*n*=843) and physical activity–focused (*n*=541) prevention research.
Note: Data are shown as percentage of prevention research projects and 95% CIs. Categories are not mutually exclusive, as some research projects contained both diet- and physical activity–focused research and some research projects had more than 1 study design. Fewer than 10 projects were manually coded in the Unclear study design category for prevention research focused on physical activity, which may make estimates from these data unstable.

from the DGAC Scientific Report (Figure 3a), and 54.4% (95% CI=48.0%, 60.8%) of physical activity–focused prevention research addressed research areas identified in the PAGAC Scientific Report (Figure 3b). One area (nutrition transitions in childhood) was observed in >10% (15.8%, 95% CI=12.9%, 19.2%), and 4 areas (dietary patterns, food environment, added sugars and sweeteners, and personalized nutrition) were observed to be addressed in 5%–10% of the diet-focused prevention research portfolio (Figure 3a). All other DGAC questions were observed to be addressed in <1% of diet-focused prevention research (i.e., food composition databases; supplements above the upper limit and biomarkers of high-dose supplement use; surveillance on prevalence/trends of nutrition-related chronic disease; food insecurity; research methods in body composition, weight status, and diet quality; effect of the Child and Adult Care Food Program; sustainability; MyPlate; aspartame intake related to cancer and pregnancy outcomes; sodium intake; health effects of dietary fat; and dietary patterns behaviors in small children). A quarter (25.9%, 95% CI=21.5%, 30.8%) of physical activity–focused research projects addressed promotion of physical activity, 6.2% (95% CI=4.3%, 8.9%) addressed the role of physical activity in brain health, and all other identified research areas were addressed in <5% of physical activity–focused prevention research (i.e., older adults; youth; individuals with chronic conditions; pregnant or postpartum women; cardiometabolic health and prevention of weight gain; sedentary behavior; cancer prevention; all-cause mortality and cardiovascular disease incidence and mortality; and steps, bouts, and high-intensity training; Figure 3b). Only a representative sample of research projects were coded to provide a general sense of the coverage of areas of research needs; thus, no detailed statements were made about the research addressing very specific research gaps.

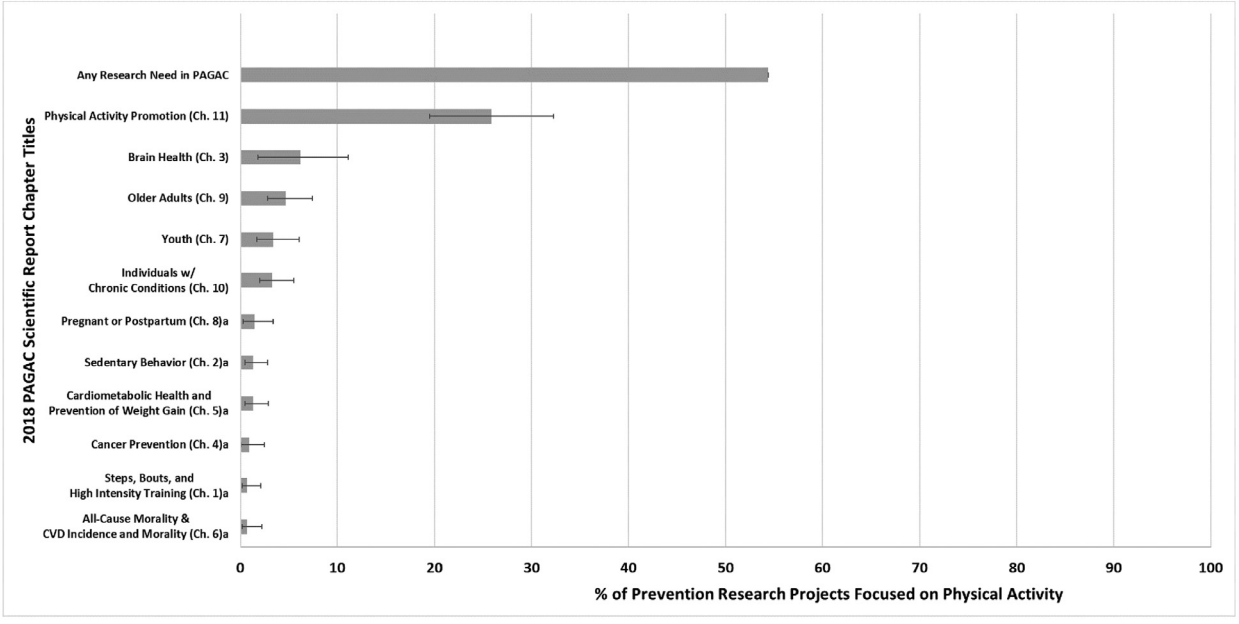
DISCUSSION

Poor diet and physical activity are major drivers of human disease. This study observed that NIH-supported prevention-related research on diet and physical activity remained steady from fiscal years 2012 to 2017 at 7.8% and 5.0% of all newly awarded prevention research, respectively. NIH-supported prevention research generally remained steady at 16.7% of all NIH research over the same time period[22]; thus, only about 1% of NIH research projects were focused on prevention research relevant to diet or physical activity during that time period. Comparing this modest proportion of prevention research funding to the observation that 19.1% and 3.3% of deaths and 10.4% and 1.2% of disability-adjusted life years lost in the U.S. can be attributed to diet and physical activity, respectively,[1] suggests a potential need for further research investment to identify effective approaches for improving health through these important health behaviors.

The diet-focused prevention research portfolio addressed DGAC Scientific Report research needs approximately 50%



(a)



(b)

Figure 3. Breakdown of NIH-funded diet- or physical activity-related prevention research by known research gaps.

Note: (a) Diet-related prevention research projects funded by NIH in fiscal years 2012–2017 that align with the 2015 DGAC Scientific Report Needs for Future Research (n=843). A total of 29 themes within the scope of the NIH Mission were identified from Appendix E-1: Needs for Future Research in the 2015 DGAC Scientific Report, and research projects were compared with these needs. Only themes that are addressed by more than 1% of the dietary prevention research projects are shown graphically. Themes occurring at <1% of dietary prevention projects include the following, where the number in parentheses corresponds to the chapter number in Appendix E-1: Needs for Future Research of the 2015 DGAC Scientific Report: food composition databases (1), 0.5%; supplements above the upper limit and biomarkers of high dose supplement use (1), 0%; surveillance on prevalence/trends of nutrition-related chronic disease (1), 0.8%; food insecurity (3), 0.9%; research methods in body composition, weight status, and diet quality (4), 0.1%; effect of the Child and Adult Care Food Program (4), 0.1%; sustainability (5), 0.7%; MyPlate (5), 0.6%; aspartame intake related to cancer and pregnancy outcomes (5), 0%; sodium intake (5), 0.4%; health effects of dietary fat (5), 0.7%; and dietary patterns behaviors in small children (3), 0.2%. Any Research Needs in DGAC is the total percentage of diet-focused prevention research that addressed at least 1 research theme identified in the DGAC Scientific Report. (b) Physical activity–related prevention research projects funded by NIH in fiscal years 2012–2017 that align with the 2018 PAGAC Scientific Report Needs for Future Research (n=541). A total of 6 overarching research needs and/or 93 unique

of the time. As the DGAC Scientific Report was released in 2015, some of the research characterized in this analysis could have been proposed in response to the Report. However, even if most of the research was not designed in response to the gaps, it provides a snapshot of which areas the field is already addressing and those that remain to be addressed. Most notably, higher percentages of research in the areas related to children, food environments and eating venues, dietary patterns, sugar-sweetened beverages, and personalized nutrition reflect areas that were addressed for the first time or with more detail in the 2015 DGAC Scientific Report compared with previous reports.

Similarly, approximately half of NIH-supported physical activity–focused prevention research was observed to address at least 1 research need identified in the recent PAGAC Scientific Report. This report was published in 2018; therefore, these research projects would not have been proposed in response to gaps identified by the PAGAC Scientific Report but, again, this analysis provides an overview of the work the field is already doing in addressing these research needs. The higher percentages of research projects in several areas, such as brain health and physical activity promotion, reflect the growth in the evidence base for these 2 areas, which were addressed for the first time in the 2018 PAGAC Scientific Report. This review provides a specific snapshot in time of physical activity research and indicates opportunities for more research in areas of need described by the PAGAC.

Both portfolios often included intervention research, which is not common among NIH-funded prevention research in general.[22] However, a high-level review of these studies revealed that the size of these intervention studies was often small, limiting the potential for translation. Both also often focused on obesity as an outcome, which likely is due to the cross-cutting impact of obesity across many NIH Institutes and Centers. For example, the NIH Obesity Research Strategic Plan[24,25] includes many opportunities for further research related to the potential role of diet and physical activity in the prevention of obesity. Multiple NIH Institutes, Centers, and Offices work collaboratively to support new research in this area. One example of such an effort was the recent NIH-sponsored Pathways to Prevention Workshop on Methods for Evaluating Natural Experiments in Obesity, which sought to advance more-rigorous research methods in this rapidly evolving area of research.[26] In addition to addressing methodologic gaps related to the design of studies and analytic approaches, this workshop also addressed key gaps in the assessment of diet and physical activity exposures. Challenges in measuring diet and physical activity underpin the lack of strong research in many areas of need identified by both scientific reports. The challenges of supporting methodologic research through the NIH investigator-initiated research system has been identified for many fields of research. One approach used by NIH to address this challenge is the use of the Common Fund Program, which seeks to catalyze research and tools that may advance research across multiple biomedical disciplines.

Limitations

Though comprehensive, limitations of this analysis should be noted. A representative sample of research projects, not all research projects, were coded; therefore, some uncertainty exists in the estimates although the CIs are not wide. Sampling also limited the ability to address rare observations; therefore, results that were extrapolated from fewer than 10 coded research projects were flagged. This analysis focused only on new, NIH-funded Extramural research using only activity codes commonly used for prevention research. Therefore, research contracts, NIH Intramural research, and other activity codes were not included in this analysis. Research projects were coded aim by aim and included in the analysis if at least 1 aim met the study criteria even if other aims did not. Finally, this analysis only included research in humans and therefore did not include more basic research (e.g., animal models, cell models, or basic biobehavioral) that may contribute to future prevention-relevant discoveries.

CONCLUSIONS

This analysis demonstrates an opportunity for greater investment in disease prevention research focused on diet and physical activity to support the development of effective interventions for the betterment of human health. It also highlights the need to consider approaches for aligning future research with research needs identified through major national reports and reviews. The NIH intends to continue monitoring its prevention research portfolio that focuses on these vital disease risk factors.

research needs were identified within the 11 chapters in the Report, and research projects were compared with these needs. The numbers in parentheses correspond to the chapter titles in the 2018 PAGAC Scientific Report. Any Research Needs in PAGAC is the total percentage of physical activity–focused prevention research that addressed at least 1 of the chapter specific and/or overarching research needs identified in the PAGAC Scientific Report.

[a]Indicates < 10 projects were manually coded in this category, which may make estimates from these data unstable.

CVD, cardiovascular disease; DGAC, Dietary Guidelines for American Committee; PAGAC, Physical Activity Guidelines Advisory Committee.

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SUPPLEMENTAL MATERIAL

Supplemental materials associated with this article can be found in the online version at https://doi.org/10.1016/j.amepre.2019.07.023.

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