Nonmedical Interventions For Type 2 Diabetes: Evidence, Actionable Strategies, And Policy Opportunities

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Abstract

This systematic review identified studies of nonmedical interventions designed to reduce risk for and improve clinical outcomes for type 2 diabetes. Specifically, this review sought to identify interventions that target structural racism and social determinants of health. To be included, studies were published in English; published between database initiation and January 2022; conducted in the United States; measured an intervention effect using a clinical trial, quasi-experimental, or pre-post design; included a population of adults at risk for or with type 2 diabetes; and targeted hemoglobin A1c levels, blood pressure, lipids, self-care, or quality of life as outcomes. The findings of our review indicate that interventions with targeted, multicomponent designs that combine both medical and nonmedical approaches can reduce risk for and improve clinical outcomes for type 2 diabetes. HbA1c levels improved significantly with the use of food supplementation with referral and diabetes support; the use of financial incentives with education and skills training; the use of housing relocation with counseling support; and the integration of nonmedical interventions into medical care using the electronic medical record. Our findings demonstrate that the literature on nonmedical interventions designed to address relevant social factors and target structural racism is limited. The article offers actionable strategies and identifies policy opportunities for targeting structural inequalities and decreasing social risk among adults with type 2 diabetes.

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Diabetes, which affects 11.3 percent of the US population, is the seventh leading cause of death in the nation.[1] Over the course of the past twenty years, the number of US adults with diabetes has more than doubled, with type 2 diabetes accounting for 90–95 percent of all diagnosed diabetes cases.[2] Type 2 diabetes confers significant risk for complex morbidity and early mortality.[3] Health disparities in the burden of type 2 diabetes are long-standing and persistent, as ethnic and racial minority populations continue to experience higher morbidity and mortality compared with non-Hispanic White populations.[4]

Extensive work has addressed medical factors, such as clinical inertia, that contribute both to the burden of type 2 diabetes and to the health disparities associated with that burden.[5] In addition, a broad literature base links social determinants of health to health outcomes and disease prevalence in adults with type 2 diabetes. This work, summarized in online appendix A, highlights evidence for relationships with the food environment, neighborhood factors, the built environment, housing stability, chronic stress, and economic instability and poverty.[6] Prior work also highlights the importance of the integration of social or nonmedical care with medical care (see appendix A).[6] However, there has been less emphasis in the literature on nonmedical interventions and on the integration of social determinants of health into diabetes interventions.[7] In addition, the evidence testing interventions that incorporate components targeting social determinants of health remains limited. Even less attention has been placed on structural racism as both the antecedent to and a way of perpetuating social determinants of health. *Structural racism* is defined as the many ways in which societies foster racial discrimination via mutually reinforcing inequitable systems;[8,9] examples include mass incarceration, historic redlining or residential segregation, and education policies. Although it is a long-standing factor contributing to health disparities and inequity,[10] only recently has structural racism been established as a key factor underlying disparities in type 2 diabetes.[11]

To account for structural racism as a root cause of health disparities in type 2 diabetes and the burden of type 2 diabetes on society, several factors must be addressed. First, understanding the evidence for nonmedical interventions that incorporate social factors and structural racism is critical. Second, implementing actionable strategies built on the existing evidence base is warranted. Third, policy-informed opportunities that span clinical and research expertise are needed to allow for a targeted approach to addressing health disparities in type 2 diabetes.

The objective of this study was to conduct a systematic review to identify nonmedical interventions to reduce risk for and improve clinical outcomes in type 2 diabetes. We sought to identify interventions that target structural racism and social determinants of health in adults with type 2 diabetes. Based on our results and the larger literature on social determinants, we offer actionable strategies to integrate medical and social interventions and identify opportunities for evidence-informed policy.

Study Data And Methods

INFORMATION SOURCES, ELIGIBILITY CRITERIA, AND SEARCH

The identification, screening, and selection of studies for final synthesis followed Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines.[12] We established inclusion criteria a priori to include studies that were published in English; were based in the United States; had an intervention effect measured using clinical trial, quasi-experimental, or pre-post study design; and had a sample population of adults ages eighteen or older at risk for or with type 2 diabetes. In addition, inclusion required that the study examine one or more of the following outcomes: hemoglobin A1c levels, blood pressure, lipid levels (for example, low-density lipoprotein [LDL] cholesterol), self-care, or quality of life. See appendix B for exclusion criteria and additional details regarding selection procedures.[6]

Appendix D includes Medical Subheading (MeSH) terms used in the reproducible search strategy to identify nonmedical clinical interventions designed to address one or more social determinants of health, using the Healthy People 2020 framework, with the addition of structural racism.[6] Appendix E presents the PRISMA flow diagram outlining the search process.[6] The search used three different databases to ensure the inclusion of a robust set of articles: PubMed, Cochrane, and Medline. The search included no date parameters. We conducted the search in January 2022.

LIMITATIONS

The study had some limitations worth noting. First, studies that were not published in one of the three databases we searched or that focused on outcomes outside of those specified in the inclusion criteria of our search were not included in this synthesis of evidence. For example, we did not include studies that focused solely on dietary measures or weight, but they may be of interest for future research. Second, given the paucity of evidence, it is difficult to make definitive conclusions that strategies identified will be effective in all populations, particularly those outside the inclusion criteria for this review (adults at risk for or with type 2 diabetes living in the US). Third, given the state of the evidence, it was not possible to investigate whether some subgroups did better than others or to determine whether there was a pattern to the impact of interventions on subpopulations. Future work should investigate these limitations as the body of evidence grows.

Study Results

After removing duplicate articles and applying the inclusion and exclusion criteria, the review included a total of ten articles for final synthesis; each article reported on a study that examined a specific aspect of a social determinant of health that is relevant to type 2 diabetes. Of the ten studies, three focused on addressing food insecurity (an aspect of the food environment) to improve outcomes in patients with type 2 diabetes;[13–15] three were categorized as addressing social risk because the intervention focused on the use of financial incentives to improve outcomes in patients with type 2 diabetes;[16–18] two focused on the integration of medical care with nonmedical care to improve outcomes in patients

with type 2 diabetes;[19,20] one focused on the built environment;[21] and one focused on improving housing and its impact on type 2 diabetes outcomes.[22] Although structural racism was included as a search term, we found no relevant intervention studies among adults with type 2 diabetes. Appendix C provides details on the studies selected for inclusion in the final review.[6]

> The larger body of evidence shows observational relationships between structural racism, social determinants of health, and diabetes outcomes.

Of the ten studies included in our review, eight were randomized clinical trials, and two used pre-post study designs. Sample sizes ranged from 35 to 4,498 people. Nine studies examined the treatment of type 2 diabetes, and one study examined an intervention's impact on prevention of type 2 diabetes. All ten studies included HbA1c, which is the gold standard for diabetes control, as an outcome. Although recommended HbA1c targets may vary based on individual characteristics and risk factors, national guidelines recommend an HbA1c of less than 7 percent for optimal health and to avoid complications.[23] Seven of the ten studies demonstrated a statistically significant reduction in HbA1c postintervention; three of these reductions were also clinically meaningful (that is, were 0.5 percentage points or more). Appendix F provides descriptive information for each article included in the review, and appendix G provides a summary of the intervention components of the articles included in the review.[6]

ADDRESSING THE FOOD ENVIRONMENT

Hilary Seligman and colleagues conducted a pre-post intervention across three state food pantries in which once or twice a month, 687 adult patients with type 2 diabetes received food boxes that were tailored to be appropriate for diabetes-related diet recommendations. The patients also received referrals to primary care providers, diabetes-specific support, and diabetes education as needed. At a six-month follow-up, the group's average HbA1c was statistically significantly lower (7.96 percent) than at baseline (8.11 percent)—a 0.15-percentage-point decrease.[13]

Seligman and colleagues also conducted a randomized controlled trial in food pantries in which 568 adults ages eighteen and older who had type 2 diabetes were randomly assigned either to a control group or to receive twice-monthly food packages with diabetes-appropriate foods and diabetes self-management education tailored to meet literacy and other participant-specific needs (provided in a pair of two-hour sessions), as well as written materials. The results of this trial showed a decrease in food insecurity but no significant difference in HbA1c levels between groups.[14]

Eleanor Weinstein and colleagues conducted a randomized controlled trial in seventy-eight adults ages eighteen and older who had type 2 diabetes and a body mass index (BMI) higher than 25 kg/m^2 (categorized as overweight or obese) to examine the impact of a $6 farmers' market voucher and a one-hour group education session taught by a physician or trained medical student, using materials from the American Diabetes Association that were focused on maintaining a healthy diet, BMI, and glycemic control. Participants' glycemic control improved at the twelve-week follow-up visit in both groups: The intervention group's HbA1c level decreased 0.8 percentage points, from 9.2 percent at baseline, and

the usual care group's HbA1c level decreased 0.9 percentage points, from 9.4 percent at baseline. However, the difference in reduction between the two groups was not statistically significant.[15]

FINANCIAL INCENTIVES TO IMPROVE OUTCOMES

Judith Long and colleagues used a randomized controlled trial of 118 African American veterans ages 50–70 who had type 2 diabetes to examine whether peer mentoring or the use of financial incentives, compared with usual care, would effectively improve glycemic control. Participants in the peer-mentoring group received tailored telephone calls from their peer mentor, whereas participants in the financial incentive group did not receive peer calls or education or skills training, receiving only a financial incentive of up to $200 for decreasing their HbA1c level by the conclusion of the trial, which ended at six months. Those in the financial incentive group showed a decrease in HbA1c of 0.45 percentage points compared with a decrease of just 0.1 percentage points for those in the usual care group; however, this decrease was not statistically significant.[16]

Leonard Egede and colleagues used a randomized controlled trial design to examine the impact of financial incentives combined with education and skills training for sixty African American adults with type 2 diabetes. This study examined three separate incentive structures on HbA1c at three months, with the incentives targeting key behaviors related to diabetes self-management and glycemic control, allowing for up to $300 in incentives to be earned during a three-month period. Group 1 represented a low-frequency financial incentive structure in which participants could receive a single incentive for an absolute drop in HbA1c from baseline to three months. After three months, if the patients experienced a 2-percentage-point drop in HbA1c from baseline or their HbA1c level was 7 percent or lower, the participants received a reward of $300. If their HbA1c dropped by 1 percentage point from baseline or their HbA1c level was 7–8 percent at three months, the participants received a reward of $150. Group 2 represented a moderate-frequency financial incentive structure in which participants could receive a reward for a change in HbA1c from baseline to three months that was similar to the incentive offered to group 1, as well as a weekly award for checking their blood glucose and another if their blood glucose values were within range. Specifically, participants could receive an additional $10 weekly for three months for uploading their glucose measurements via an online platform, with an added $3 per week if the glucose readings were 150 or below (recommended good control for blood glucose levels). Group 3 represented a high-frequency financial incentive structure in which participants could earn a reward at three months for a drop in HbA1c that was similar to those seen in groups 1 and 2; could receive weekly rewards for reporting blood glucose readings and maintaining their glucose levels within range, as seen in group 2; and also could receive $5 per week for eight weeks for attending health education sessions. Each group had the potential to earn up to a total of $300 at three months. The findings from this study showed statistically significant reductions in HbA1c from baseline across each study group: a 1.25-percentage-point reduction for the group receiving a single incentive (group1), a 1.73-percentage-point reduction for the group receiving a two-part incentive (group 2), and a 1.74-percentage-point reduction for the group receiving a three-part incentive (group 3).[17]

Aditi Sen and colleagues used a randomized controlled trial design to randomly assign seventy-five adults ages 18–80 to high incentives, low incentives, or no incentives. The high- and low-incentive groups were offered lottery-based financial incentives based on daily use of and an upload of readings from a glucometer, blood pressure monitor, and scale. Participants in the incentive groups received daily text or email messages notifying them of their incentive for the day, with those who did not use the devices or upload their results receiving a notification of how much they would have received had they used the devices. There were no statistically significant differences between the groups for systolic blood pressure, but HbA1c levels dropped a statistically significant 1.5 percentage points between baseline and twelve weeks in the high-incentive group and 1.2 percentage points in the low-incentive group.[18]

INTEGRATION OF MEDICAL CARE AND NONMEDICAL CARE

Interventions that integrated medical care with nonmedical care were included if there was purposeful integration into the medical intervention of the social or nonmedical aspects of a patient's lived experience that affected disease management. Lydia Chwastiak and colleagues used a randomized controlled trial design to examine the impact of a collaborative care team intervention on twenty-five adults with a mental health diagnosis and type 2 diabetes. The intervention included six biweekly (every other week for twelve weeks) chronic disease self-management education sessions followed by monthly visits for up to six months, provided by a multidisciplinary care team. A key component of the integration of medical with nonmedical care was the use of motivational interviewing and behavioral activation to specifically navigate barriers to engagement in self-management experienced in patients' daily lives. Patients in the intervention group had a statistically and clinically significant decrease in mean HbA1c levels from 9.4 percent to 8.3 percent (1.1 percentage points) at three-month follow-up.[19]

James Graumlich and colleagues used a randomized controlled trial design with 674 adults ages forty and older who had type 2 diabetes to test the effectiveness of the Medtable tool implemented within the Epic electronic medical record in outpatient clinics, to facilitate the organization of collaborative patient and provider interactions for medication reconciliation, review, and education. Specifically, this tool integrated the clinical management of medication management with patient education designed to address patient literacy barriers to medication management. The results showed a statistically significant decrease in mean HbA1c levels (0.12 percentage points) for all patients, regardless of intervention group.[20]

The results of this review highlight the potential for positive impact when interventions address both social and medical needs.

ADDRESSING THE BUILT ENVIRONMENT

Lindsay Mayberry and colleagues used a pre-post design of eighty low-income adults with type 2 diabetes to evaluate whether a text messaging intervention to provide strategies to overcome various physical and transportation barriers to medication adherence would affect participants' glycemic control. Daily text messages were tailored to specific barriers the patients were experiencing, and a weekly call was intended to problem solve and provide strategies to overcome barriers. Specific barriers included challenges getting to the

pharmacy, fear and perceptions, and cost. At three-month follow-up, no reduction in HbA1c levels was found.[21]

ADDRESSING HOUSING STABILITY

Jens Ludwig and colleagues used a randomized controlled trial design of 4,498 women living in public housing within high-poverty neighborhoods to evaluate the impact of neighborhood reassignment using vouchers. The first group of participants received housing vouchers to move to low-poverty neighborhoods, the second group received general vouchers that were not tied to housing but that could be used to relocate, and the third group served as a control group and did not receive any form of voucher. The housing voucher group also received moving-specific counseling to support the process of identifying a new neighborhood in which to live. Participants in the housing voucher group had a 4.3-percentage-point drop in the prevalence of diabetes relative to the control group (20.0 percent in the control group versus 15.7 percent in the low-poverty voucher group; $p < 0.02$) after ten to fifteen years of follow-up. There were no significant differences in type 2 diabetes prevalence between the group that received general vouchers and the control group.[22]

SUMMARY OF KEY CHANGES REPORTED

Appendix H summarizes which of the ten studies measured one or more of three clinical outcomes (HbA1c, blood pressure, and LDL cholesterol) and indicates where statistically significant and clinically meaningful differences were found after the intervention studied.[6] Seven of the ten studies demonstrated a statistically significant reduction in HbA1c postintervention, ranging from 0.15 percentage points to 1.74 percentage points.[13,17–22] Of these reductions, three were clinically meaningful (that is, 0.5 percentage point or higher). Chwastiak and colleagues found a drop of 1.1 percentage points for those receiving integrated care for diabetes;[19] Egede and colleagues found drops ranging from 1.25 percentage points to 1.74 percentage points that were associated with the lowest and highest of three levels of financial incentives, respectively;[17] and Sen and colleagues found a drop of 1.5 percentage points for financial incentive interventions.[18]

In addition, Ludwig and colleagues found that in their low-poverty voucher group, there was a significant drop in the prevalence of diabetes relative to the control group after ten to fifteen years of follow-up.[22]

Discussion

Overall findings from this systematic review demonstrate that although the literature on nonmedical interventions designed to address social factors and target structural racism in adults with type 2 diabetes is limited, interest and activity in this area of inquiry have recently increased. The larger, existing body of evidence reviewed in appendix A[6] shows observational relationships between structural racism, social determinants of health, and diabetes outcomes. However, additional evidence showing successful interventions that incorporate these factors is needed. The current knowledge gap, combined with the promising findings noted in this review, presents an imperative to develop and test

interventions and programs that target upstream factors at the root of well-documented disparities in, and the societal burden of, type 2 diabetes.

Bringing together the available evidence, including the findings identified in this review, we offer actionable strategies as potential next steps to address that substantial knowledge gap. Although the studies included in this review are limited in number and scope, prior work establishes a strong relationship between social risk factors and type 2 diabetes prevalence and clinical outcomes (see appendix A),[6] and the results of this review highlight the potential for positive impact when multicomponent interventions address both social and medical needs. Therefore, we also identify relevant policy opportunities to serve as a road map for building a next generation of diabetes interventions and programs that capitalize on this potential.

Actionable Strategies

Several actionable strategies for addressing the current knowledge gap may be drawn from the findings of this review and the larger body of literature.

First, more work is needed to develop and test multicomponent interventions that address both the social needs and the medical needs of adults with type 2 diabetes, particularly among populations that experience health inequity, both historically and currently.

Second, targeting social risk factors concurrently with medical interventions has the potential to reduce and prevent the burden of diagnosed type 2 diabetes. Evidence from this review shows that HbA1c levels improved significantly for nonmedical interventions alone and for medical interventions combined with nonmedical interventions. Specifically, positive impacts were realized using food supplementation with referral and diabetes support, financial incentives combined with education and skills training, housing relocation with counseling support, and integration of medical care and social supports specifically through the electronic medical record.

The third actionable strategy is developing multilevel interventions to address structural racism by targeting system and environmental inequities, which includes addressing chronic stress at the individual level. A limited number of nonmedical interventions have been designed and tested to address a broad range of social risk factors in the prevention and treatment of type2 diabetes. However, our search did not find any nonmedical interventions related to structural racism. Nonmedical interventions were found that addressed the role of chronic stress in type 2 diabetes treatment or prevention, but there were no studies that examined potential mechanisms of action and whether the intervention led to reductions in chronic stress, ameliorated financial strain, or alleviated poverty.

Policy Opportunities

Although the findings of this review do not provide direct links to policy, four existing government policies, as well as a fifth policy sphere in which opportunities can be created, can serve as vehicles for policy-based actions that target upstream sources of elevated social risk and health disparities.

MEDICAID EXPANSION

The first government policy, which has been linked to favorable outcomes for patients with diabetes, is the expansion of Medicaid by states.[24–26] For adult patients with diabetes, such expansion has been associated with increased self-reported diabetes management[24] and improvements in diabetes biomarkers among patients at community health centers.[25] As of mid-2022 twelve states had not yet adopted Medicaid expansion. Several other states have implemented their expansions with Section 1115 waivers, which allow them to operate their Medicaid expansion programs in ways not otherwise allowed under federal law and have been tied to potential coverage losses or increased enrollment barriers within some states.[24,25] Closing the gap in state Medicaid expansion could help expand the reach of these noted benefits for more patients with diabetes. In addition, future research should investigate the effect of expanding Medicaid to cover the costs of nonmedical interventions that have been shown to be effective, such as food supplementation with referral and diabetes support. Coverage of food supplementation based not only on medical need but also on financial need is one aspect of expansion with the potential to address social needs.

HEALTH SYSTEM VULNERABILITY

Second, policies are warranted to help ameliorate vulnerabilities of our health system in times of systemic shock, such as that presented by the COVID-19 pandemic. Estimates from Kaufman Hall noted that the effects of COVID-19 could leave half of US hospitals with negative margins, placing them at greater risk for closure.[27] In cases where these adverse financial pressures may result in hospital or clinic closures among safety-net providers, already-vulnerable communities may be left with little to no nearby health care access. Unless averted by means of hospital and clinic financial support, such losses may act to further exacerbate preexisting racial and ethnic health disparities related to both COVID-19 and diabetes.[28,29] Research is needed on how to best tailor support to critical safety-net providers, especially within inner-city communities.

BILLING PRACTICES

Third, policy changes that broaden the existing coverage of the No Surprises Act, which became effective January 1, 2022, and help establish new billing practices for uninsured patients also have the potential to address upstream factors that result in poor outcomes for people with type 2 diabetes. Between 2019 and 2020 one in eleven people in the US reported having to delay care because of the cost,[30] and 62.1 percent of personal bankruptcies in the US have been found to be health care related.[31] Patients who have diabetes and who are uninsured are particularly vulnerable because they have high medical care needs and are commonly billed at chargemaster rates, which are frequently inflated several orders of magnitude above what would be billed to public or private payors.[32] Research is needed to examine the impact of changes in billing practices for uninsured patients on diabetes outcomes to better understand the nuances of needed legislation.

LABOR MARKET

Fourth, potential policy levers within the labor market targeting social mobility and social infrastructure have potential, including minimum wage and paid time off. These policy

levers may affect not only social risk factors but also health outcomes. Prior work found that increased minimum wage is associated with declines in death rates and an increase in life expectancy.[33] Recent evidence shows that paid time off improves mental health,[34] reduces probability of working while sick,[35] and reduces racial and socioeconomic disparities.[36] Although evidence tying these outcomes specifically to people with type 2 diabetes is largely missing, this represents an important avenue for future research.

HOUSING

Finally, there is the potential for impact through the expansion of existing Department of Housing and Urban Development programs such as the Community Development Block Grant Program and the housing choice voucher program (Section 8 vouchers). Experiments such as the Moving to Opportunity for Fair Housing demonstration found that adult participants who received vouchers had a significantly lower prevalence of diabetes, extreme obesity, and psychological distress ten to fifteen years after enrolling in the experiment.[37] Although programs such as the Community Development Block Grant Program have been notably understudied, recent work suggests that place-based initiatives may have the greatest beneficial effects on employment if directed toward subsidizing employment in areas with historically high nonworking populations.[38] The linkage of such policies to diabetes outcomes represents a promising new area for investigation.

Conclusion

This systematic review revealed the need to build a larger evidence base for nonmedical interventions targeting social determinants of health and the structural racism that both gives rise to them and helps perpetuate differential, negative impacts of type 2 diabetes at the individual and population levels. Actionable strategies outlined in this article may be used as a guide to build that empirical foundation to improve clinical outcomes for adults with type 2 diabetes. Multiple policy opportunities also exist that have the potential to target structural inequalities in health as pathways to decrease social risk and improve health outcomes for this segment of the US population.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

NOTES

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