Why the lack of progress if good interventions exist? While prevention may be conceptually straightforward, diabetes itself is terrifically complex. It strikes slowly and progresses unpredictably, with possible complications covering a broad landscape from blood clots to renal failure, glaucoma to degenerative nerve disorder. Negative outcomes span decades and are hard to forecast, with different patients following very different disease pathways; their costs are dispersed across payors and systems. This complexity challenges our ability to make reliable claims of long-term impact from today’s interventions and their near-term outcomes, and it obscures much of the value created by prevention.

Nevertheless, we at Social Finance US—following in the footsteps of our colleagues in Israel—believe there is an opportunity to scale high-quality diabetes prevention via Pay for Success (PFS), creating significant short- and long-term value for both payors and beneficiaries. Pay for Success has been used to fund over 60 projects worldwide, from early childhood home visiting expansion in South Carolina to ‘social prescribing’ for lifestyle management of chronic diseases in Newcastle, UK. Following a critical review of intervention evidence, and drawing on recent additions to the field in estimating the value of prevention, we believe that lifestyle interventions in the model of the Diabetes Prevention Program can improve health and save money—and that Pay for Success can be a useful tool to help scale these programs up, preventing one of the most deadly and costly diseases in America.
**Prevention Tools That Work**

The US is home to hundreds of diabetes prevention interventions, offered by both nonprofits and for-profits, in clinics and in homes, by highly trained and by lay health workers. In the process of this study, we reviewed many of them. We found a great deal of innovation, and a much more limited bedrock of strong experimental evidence.

Any investigation of the diabetes prevention landscape in the US hinges on the field’s landmark Diabetes Prevention Program (DPP) study. The large, multicenter 2002 study matched participants with one-on-one support from a well-qualified lifestyle coach, based in the clinic, to improve nutrition and physical activity.

DPP—and other, similar programs, tested in randomized controlled trials around the world—was wildly successful. It demonstrated a 58% reduction in diabetes incidence over nearly 3 years versus a randomized control group. It was so successful that researchers, following the initial window, broke randomization, providing a modified version of the intervention to those in the control group. Nevertheless, the impact of those first three years persisted: after 10 years, DPP continued to reduce the incidence of diabetes by 34% versus the original control group.

In the years since, numerous programs have attempted to translate the DPP into lower-cost, often lower-intensity programs. These translations, we found, have a mixed record. While based on the DPP, few had performed rigorous evaluations in their own right; those that did often found significantly less impact than the original study.

Only one translation in our review transcended that finding. The Healthy Living Partnerships to Prevent Diabetes (HELP PD) employs the DPP curriculum and methods, and delivers them using registered dieticians and community health workers to groups of participants in community settings. HELP PD is shorter and less costly than DPP, but, in a randomized controlled trial conducted in Winston-Salem, North Carolina, demonstrated similar effects on blood glucose, weight, and diabetes incidence.
The Value of Prevention

Even with powerful tools at hand, making the case for prevention requires us to estimate the social and economic value of these interventions, along with how that value accrues to different stakeholders. And estimating the value of diabetes prevention poses particularly intricate challenges.

Other translations, while lacking in the same rigorous evaluations as those underlying DPP or HELP PD, have also demonstrated promise. Perhaps the most exciting is the YMCA’s Diabetes Prevention Program (YDPP). YDPP delivers an updated DPP curriculum to groups of participants via a lifestyle coach at the Y. At one year long, it is the briefest of the three interventions we prioritized, but in a small 2008 analysis demonstrated a promising 4% greater average weight loss for a lifestyle group in one site versus a control site, suggesting important impact on diabetes prevention. Further programmatic data suggest that impact on weight loss is replicable across the nation. We and other analysts believe it likely that YDPP has an important positive impact on blood glucose and diabetes incidence at a fraction of the cost of other interventions, and see its national network as a crucial opportunity for building scale. Indeed, in March 2016, the Office of the Actuary in the Centers for Medicare & Medicaid Services (CMS) certified that YDPP and programs like it would reduce overall healthcare spending, and therefore has proposed reimbursing for the program via Medicare; if the proposed CMS rule changes are finalized, expanded coverage will take effect January 1, 2018.

Despite the positive consensus, we are cautious in our expectations for HELP PD and YDPP. While HELP PD approximates DPP’s initial 2-year findings, it does so for a relatively narrow study population, who were recruited to the study in a very different manner—both of which may influence the program’s measured impact. We do not yet understand the trajectory of its long-term effects, which may dilute faster than DPP’s. (Indeed, it may be that the very act of ongoing DPP evaluation is driving its effect; lacking the longitudinal follow-up, HELP PD may also have more limited long-term adherence.)

The YDPP, for its part, has not yet been subject to a rigorous outcomes evaluation, suggesting greater uncertainty still—both in its short- and long-term outcomes. Meanwhile, analysts have made a variety of assumptions about the relative effectiveness of the Y’s program. For example, in a 2014 analysis conducted for the ADA and the YMCA, Avalere Health assumed that YDPP would be 50% as effective as DPP over 10 years. The CMS actuarial report followed suit, estimating that YDPP would be 50% as effective in year one, with a 5% reduction in effectiveness each year through year seven (and a constant 20% effectiveness rate thereafter). Researchers at the CDC and the RTI-UNC Center of Excellence in Health Promotion Economics made slightly different assumptions still, estimating a 50% relative reduction during the first two years, and then assuming a constant 15% effect thereafter. These assumptions are critical to modeling expected cost benefit; while consensus around the positive impact of YDPP exists, there is significant variation on the set of assumptions and analyses underlying that consensus.
For one thing, it’s easy to misinterpret data about the value of prevention. Too often, analysts conflate the value of prevention with the cost of illness. As is often cited, diabetic patients cost, on average, $7,888 more than nondiabetics. But those costs do not appear as soon as a patient is diagnosed. The greatest cost burdens accrue in the later stages of the disease; significant divergence in costs between those who get diabetes and those who don’t takes time. Understanding the progression of diabetes is essential to understanding the value of prevention, because cost differences in the short term are much smaller than those later on.

Unfortunately, it’s hard to predict disease progression and cost for a given patient. Diabetes development and complication rates vary by age, gender, and race. Importantly, prediabetics represent a relatively wide band of risk and impaired glucose tolerance. Costs, too, vary significantly across patient populations: patients diagnosed early (e.g., at age 40), for example, have greater lifetime costs—and their costs go up more quickly than patients diagnosed later in life.

Even to the extent that learning from the past can guide cost projections, there’s the abiding challenge that the future of diabetes costs just might not reflect that past. Because many costs occur decades after intervention, the counterfactual is murky: future diabetes treatment costs may change, subject to both improved medical technologies and increased longevity, and thereby erode—or, less optimistically, improve—the value of prevention.

Prevention modeling, then, is a tricky business.

An elite set of health economists have taken on these challenges. In the past decade, at least 10 high-quality diabetes simulation models have been developed around the world. They typically employ data from dozens of evaluations to extrapolate results across longer time periods and across alternative populations. As opposed to large “cost-of-illness” studies, simulation models are intended to describe the value of a new intervention within a population—going beyond the results of tightly-controlled clinical trials. They are complex, recursive models that predict the interaction of multiple comorbidities over time.

The most recent entry into this space comes from Tim Dall et al. at IHS Global Research Life Sciences. Their model, the Disease Prevention Microsimulation Model (DPMM), estimates the health and economic benefits of a Diabetes Prevention Program lifestyle intervention oriented toward prediabetics over the course of 10 years. Outcomes are compared between a simulated intervention, based on the Diabetes Prevention Program (discussed above), and a simulated natural disease progression.
This allows the DPMM to do some important things—like predict the true value of diabetes prevention, absent the problematic distortions of individual studies like the DPP. Ultimately, the model suggests that “the simulated economic benefits of treating prediabetes via lifestyle intervention appear to far outweigh intervention costs over the analyzed 10-year period.” Lifestyle intervention reduces 10-year cumulative per-capita medical costs by $6,300, and creates nonmedical benefits—like increased employment rates, greater household income, and lower absenteeism—of $11,500.24

The DPMM is only one of a number of sophisticated, and sometimes conflicting, simulation models. Judging the quality of such models is a highly technical pursuit. And they are only as good as the research existing in the field today, including studies and models created from non-US-based populations, and some that compare diabetic populations to non-diabetics. While the DPMM has been tested for validity against other clinical trials, it does not always match longitudinal outcomes from the Diabetes Prevention Program, the largest US-based experimental prevention study. It parts ways most notably in its ultimate conclusions around the positive economics of lifestyle interventions.25

Despite appearing more economically positive than the 10-year DPP observations, the model may still be overly conservative. Because the DPMM only models diabetes and “recognized sequelae,” it underestimates the total cost aversion produced from weight loss.26

On the whole, the DPMM is a thorough and well-informed effort to look past the challenges in prospective disease modeling, stripping away the DPP’s own methodological questions and presenting a useful estimate of the value of prevention. At a high level, we can use its results to impute the value of HELP PD and YDPP as well. Doing so requires navigating crucial assumptions underlying the long-term effectiveness of these interventions, which—as we describe above—vary considerably.

Comparative Cost-Benefit

In order to prioritize among these interventions, we next sought to compare various estimates of intervention benefit against their costs.27

Of the three programs, we feel most confident about our ability to estimate the long-term cost and benefit of the DPP, and increasingly less confident in our ability to do so for HELP
PD and YDPP. Our confidence is a factor of the information at our disposal, and we have more and better information about those interventions tested with rigorous evaluations; translational programs may be less impactful than the soup-to-nuts DPP described in the 2002 publication, and the duration of their impact may be shorter lived.

Using best-available published impact estimates, we tried to compare the likely ten-year cost-benefit ratios of the three programs. In the case of HELP PD, our estimate likely inflates the ROI, as it assumes a similar impact trajectory to DPP over time. In the case of YDPP, we found a wide range of published long-term impact estimates, creating a large possible ROI band from which we took a simple average.

On the whole, these estimates underscore the reality that, while translational programs may create somewhat less impact than the original DPP, they do so at dramatically reduced costs—making both HELP PD and YDPP better value-per-outcome propositions than DPP. Between the two, only a highly conservative estimate of YDPP effectiveness and a highly optimistic estimate of HELP PD effectiveness would suggest that HELP PD is the better bet; more likely, the low-cost YDPP intervention produces the best preventative bang for our public health investors’ collective buck.

Nevertheless, it’s worth reiterating that the evidentiary landscape and our still-limited understanding of diabetes prevention make it complex terrain. A Pay for Success project in diabetes would benefit greatly from further simulation modeling from expert economists, helping to set a neutral third-party definition of the expected value-per-outcome.

**Path Forward**

For too long, policymakers have been paralyzed by the discomfiting complexity of diabetes prevention. Prediabetes move across the borders of our gerrymandered healthcare system, and the benefits of prevention are parceled out among payors—too little to catalyze action for any one player, too great to ignore in the aggregate.

Using the tools of Pay for Success, we believe that diabetes prevention gains a new luster, allowing innovative financing to subtly shift the balance of risk and return to suit our multipayer system. We could envision doing so in a number of ways.

**Expand the Diabetes Prevention Program using Pay for Success.** Fifteen years ago, the DPP—expensive, intensive, based in the clinic and run by highly qualified providers—
demonstrated tremendous effects on diabetes prevention. Recent simulated analysis of DPP suggests that, contrary to the surprising findings in the DPP Outcomes Study, prevention is cost effective. Armed with this new information, we see expansion of the “fully-loaded” DPP as a low-risk—though relatively expensive, and hence, lower return—method of expanding diabetes prevention, which distinctly improves upon the status quo.

**Strengthen the evidence for promising models.** Translations of DPP may be able to deliver similar results at a lower cost. HELP PD has a single, high-quality randomized controlled trial (RCT) to date; a second, confirmatory evaluation—conducted in a different geography, with a more economically and racially diverse population—could vault HELP PD into the top tiers of evidence-based practice. A Pay for Success model could be designed to experiment with the intervention in a new geography, building on the program’s initial evaluation while running an RCT on the program’s new implementation.

Evaluation, of course, can be—and historically has been—accomplished independently of Pay for Success. We believe that governments and philanthropy should continue to proactively evaluate promising community translations, including both HELP PD and YDPP, to build knowledge about what works. Pay for Success may be used as a catalyst for this knowledge building.

**Scale our most promising prevention program, the YMCA’s Diabetes Prevention Program.**

The appeal of YDPP is undeniable: it is inexpensive to deliver; it draws on the national infrastructure and reputation of the YMCA; it has been recognized by the Centers for Disease Control and Prevention; and it has been certified as cost-saving by the Center for Medicare & Medicaid (CMS).

Perhaps more than other analysts, we see its risks as substantial. The evidence underlying YDPP’s effectiveness is less robust than that of DPP or HELP PD; its evaluated outcomes (in a relatively small 2008 analysis) demonstrated no effect on HbA1c, and its program data—which are focused on weight loss, rather than diabetes per se—suggest somewhat lower effect sizes than its higher-cost peers.

Despite these risks, however, the evidence strongly suggests that YDPP creates positive impact for prediabetics, and that this impact creates disproportionate public value. This impact is likely to be bolstered further—as in the Israeli social impact bond model targeting type II diabetes—by the application of new health technology, from physical activity monitors and health bracelets to online support tools.

Growth through Pay for Success would allow YDPP to expand its reach. Building on the example of CMS, other public payors—particularly States and Counties looking at healthcare for their own employees—could use Pay for Success to expand YDPP to their beneficiaries, paying only for quality implementation (aligned against the CDC’s guidelines) and near-term obesity outcomes. Public-sector employees are older; nearly 50% more likely to be diabetic;
and have longer tenure (and hence, allow preventive programs to capture greater long-term value) than private-sector employees. With the support of sophisticated simulation modeling, we believe that a PFS project to expand YDPP for public employees could make a compelling case for medium-term (~5 year) positive return on investment—and dramatic long-term returns. Ultimately, we believe that YDPP represents a low-cost, scalable solution to one of our nation’s largest public health challenges, and that Pay for Success can help finance the program as it expands.

The burden of diabetes demands new approaches toward funding and scaling prevention. We know, based on the strength of recent modeling efforts, that prevention is dramatically less expensive than remediation. What we lack is the bridge between preventive efforts today and benefits in the future—a way of ensuring that interventions are on track toward producing long-term rewards. Based on our analysis of the field’s literature, and encouraged by the pace of progress exhibited by our colleagues in Israel, we believe that Pay for Success can help to overcome the capital challenge facing diabetes prevention and reach more of those in need.


2. Ibid.


5. The process used for this scan and prioritization are described in more depth in other Social Finance publications, particularly our “How-To Guide for Nonprofit Diligence.” 2016. In short, we deprioritized programs without rigorously defined control groups, those with unreliable study designs or methods, and those that did not track relevant outcomes. (Outcomes included type 2 diabetes incidence, HbA1c, or weight loss. Diabetes incidence was defined by the rate of patients diagnosed as diabetic, generally defined by those with HbA1c >6.5%.) We also deprioritized interventions demonstrating small or no effect. Ultimately, our review process suggested a shorter list of top-priority interventions in both diabetes prevention and management. In support of this process, Social Finance spoke with national experts—thought leaders, diabetes researchers, health economists, public-sector officials, potential payors—and reviewed a wide selection of published diabetes intervention and cost-benefit literature from regional resources (such as the University of Texas Health Science Center), national best practices (such as the Centers for Disease Control and Prevention, the American Diabetes Association, the National Institute of Diabetes and Digestive and Kidney Diseases, and the American Pharmacists Association), and clearingshouses of top-tier social interventions (such as the Coalition for Evidence-Based Policy).

6. Similar results have been obtained in studies in China (1995), Sweden (1991), Finland, (2003), and India (2006).

7. They have also sought to update the DPP’s two-decade-old curriculum, which has since been influencing by changing dietary and activity recommendations.


10. Most diabetes prevention studies and researchers use weight loss as a proxy for diabetes. There is a strong correlation between weight loss and diabetes incidence. This relationship is typically defined by the DPP: in that study, researchers found that, adjusted for changes in diet and activity, “for every kilogram of weight loss, there was a 16% reduction in risk of (diabetes incidence).” Richard P. Hamman, et al., “Effect of Weight Loss With Lifestyle Intervention on Risk of Diabetes.” Diabetes Care. 2006 Sep; 29(9): 2102-2107. The Finnish Diabetes Prevention Study supported these findings. The large, multivariate Look-AHEAD trial, which tested the long-term impact of lifestyle interventions for overweight or obese patients, found that weight changes were significantly correlated with modest HbA1c reductions. (One year out, higher weight loss (~2-5%, ~5-10%) was associated with a decrease in HbA1c (~0.5-2% per category). Wing RR, et al., “Benefits of Modest Weight Loss in Improving Cardiovascular Risk Factors in Overweight and Obese Individuals With Type 2 Diabetes.” Diabetes Care. 2011 July; 34(7): 1481-1486. However, our research suggests that, while there is a strong relationship between weight loss and diabetes, it is complex, culturally reliant, and may change as the disease progresses. (It should be noted as well that obesity creates comorbidities beyond diabetes.) Other studies beyond DPP—including major evaluations in India and China, smaller translational studies in the US, and earlier weight loss research—suggest that the relationship between weight loss and blood glucose is unpredictable and nonlinear. Across dozens of interviews with diabetes researchers and clinicians, the use of weight loss as a proxy was described as “fraught,” “tenuous,” and “complex.” According to one researcher, “it’s not perfect—but for most practical studies, it’s the best we’ve got.”


Total energy intake, rather than weight loss, may be the key underlying driver in incidence reduction. Unlike DPP, the 1968 Diabetes Study in Du Ong, China, which used a randomized cluster analytic test to link nutrition and exercise strategies in preventing diabetes, found decreases in diabetes incidence despite only very modest (~1 kg) weight reductions. According to Tuomilehto et al., “this indicates that body weight alone may not be the most critical issue in the prevention of type 2 diabetes.” Tuomilehto J, et al., “Long-term Benefits From Lifestyle Interventions for Type 2 Diabetes Prevention,” Diabetes Care. 2011 May; 34 (Supplement 2): S210-S214. A randomized controlled trial in India showed a smaller, but still strong, relative reduction of diabetes incidence versus the control (~26-28% for different arms of the study). However, according to Ramachandran et al., “weight reduction and change in plasma glucose were not significantly correlated in any of the intervention groups.” Ramachandran A, et al., “The Indian Diabetes Prevention Programme shows that lifestyle modification and metformin prevent type 2 diabetes in Asian Indian subjects with impaired glucose tolerance (IDPP-1).” Diabetes (Oxford). 2008; 46: 298-307.

In the US, two earlyweight studies produced inverse results. A 1988 study of weight loss strategies by R.M. Manning et al. tested a 3-month course of a since-withdrawn appetite suppressant on diabetic patients. At three years, they found that the drug had long-term impacts on weight loss, but did not result in improved glycemic control. Manning RM, et al., “The comparison of four weight reduction strategies aimed at overweight patients with diabetes mellitus: four-year follow-up.” Diabetes Medicine. 1995 May; 15: 497-502. Another 1990 study concluded that, “in contrast to conventional teaching, many patients with non-insulin-dependent diabetes mellitus...

More recent studies similarly raise questions about the clear relationship between weight loss and blood glucose. In the DPP community translations we reviewed, for example, three tracked HbA1c change—but only one of intervention and economic benefits was an impact on HbA1c. On the whole, diabetes and weight appear to be deeply related, and certainly weight loss is a less cumbersome metric to track, presenting fewer barriers to enrollment, lower costs of delivery, and fewer challenges to storing and communicating secure health information. However, our literature review suggests that it is worth being cautious about this relationship.


15. It is worth noting that preventative efforts are not prevention per se, while in some cases they may entirely avert the disease for some patients, more often these programs show increases in HbA1c, delay onset, and thereby mitigate some of the disease’s worst complications. Even patients who never become diabetic (for whom the disease has been “prevented”) may still have elevated HbA1c within the prediabetic range and suffer long-term health consequences. Thus, models risk overestimating the incremental cost of diabetes by comparing diabetics against non-diabetics. Such models may accurately achieve their objectives—describing the total social and economic costs of diabetes—but we should be careful not to use these estimates to describe the value of preventative efforts.

16. Over the long term, the effect of prevention on lifetime healthcare utilization is a much nuanced picture, because increased lifetime expectancy makes some of the prescriptive savings.

17. Note that while prevention helps to delay treatment costs, it also extend life expectancy and therefore increase lifetime medical spending. Of course, when viewed through a cost-per-DALY lens, these challenges may be mitigated. Xiuahui Zhu, et al. (2014)


19. Ibid.


21. Such models are typically data-driven—recursive mathematical structures that describe disease progression as probabilistic transitions between a fixed number of states. Such models can account for the complexity of diabetes progression by annually recalculating the risk, for a given population, of developing a given morbidity. In this way, they model the future health and costs of a set of diabetic patients.


23. 2014 dollars, using 3% discount rate.

24. When comparing the 10-year costs of lifestyle intervention to metformin and placebo groups, the Diabetes Prevention Program Outcomes Study (DPPOS) found that “the cumulative, combined costs were greatest for lifestyle and least for metformin ($31,362 vs. $29,665 vs. $29,759 per patient).” That, after 10 years, the lifestyle intervention was “cost-effective”—in that it produced significant health benefit for relatively limited costs—but was not cost saving. However, the authors introduce an important methodological caveat. DPPOS compared a lifestyle intervention against a control only for the first 2.8 vs. 10 years of study. Following the nearly 10 years of the DPP intervention, the placebo group was un-blinded and offered a less-intensive version of the DPP intervention. Over half of the placebo group participated in at least one such session—therefore receiving more than ‘usual care.’ “Thus,” wrote the DPPOS authors, “if real-world usual care was used for comparison, the difference between lifestyle and placebo might have been greater.” In addition to this challenge, the DPPOS authors introduce an important methodological challenge of DPPOS—estimating the impact of un-blinding the control group on the 10-year efficacy of the intervention. They must also estimate (or measure) how the program’s effect changes with various alterations to the program model. Nevertheless, DPPOS demonstrates tremendous promise. At ~15% the cost of the DPP, it must create only a fraction of the DPP’s effect size in order to compete on a cost-per-outcome basis, given that the YODPP is based on the DPP curriculum and replicates its impact on weight loss, seems highly plausible. Multiple studies of lifestyle intervention programs have found that lifestyle intervention programs can lead to a ~15% reduction in the risk of diabetes. Indeed, the Diabetes Prevention Program Outcomes Study (DPPOS) found that the “cumulative, combined costs were greatest for lifestyle intervention ($31,362 vs. $29,665 vs. $29,759 per patient).” That, after 10 years, the lifestyle intervention was “cost-effective”—in that it produced significant health benefit for relatively limited costs—but was not cost saving. However, the authors introduce an important methodological caveat. DPPOS compared a lifestyle intervention against the control only for the first 2.8 vs. 10 years of study. Following the nearly 10 years of the DPP intervention, the placebo group was un-blinded and offered a less-intensive version of the DPP intervention. Over half of the placebo group participated in at least one such session—therefore receiving more than ‘usual care.’ “Thus,” wrote the DPPOS authors, “if real-world usual care was used for comparison, the difference between lifestyle and placebo might have been greater.” In addition to this challenge, the DPPOS authors report that “the costs of medical care outside the interventions appeared[s] low and were not a major driver in the lifestyle arm of the study.” While the DPPOS measured significant effect sizes between the control and experimental populations, these effects did not translate into cost savings as expected. The Diabetes Prevention Program Research

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Social Finance US is a nonprofit that is dedicated to mobilizing capital to drive social progress. We believe that everyone deserves the opportunity to thrive, and that social impact financing can play a catalytic role in creating these opportunities. Jake Segal (jsegal@socialfinance.org) is a Director on the Advisory team.

The Humana Foundation was established in 1981 as the philanthropic arm of Humana Inc., one of the nation’s leading health and well-being companies. Located in Louisville, KY, the Foundation seeks to improve community health and well-being through support of nonprofit partners that promote healthy behaviors, health education, and access to health services.