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RESEARCH ARTICLE

Benefits of Meeting the *Healthy People 2030* Youth Sports Participation Target

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Introduction: *Healthy People 2030*, a U.S. government health initiative, has indicated that increasing youth sports participation to 63.3% is a priority in the U.S. This study quantified the health and economic value of achieving this target.

Methods: An agent-based model developed in 2023 represents each person aged 6−17 years in the U.S. On each simulated day, agents can participate in sports that affect their metabolic and mental health in the model. Each agent can develop different physical and mental health outcomes, associated with direct and indirect costs.

Results: Increasing the proportion of youth participating in sports from the most recent participation levels (50.7%) to the *Healthy People 2030* target (63.3%) could reduce overweight/obesity prevalence by 3.37% (95% CI=3.35%, 3.39%), resulting in 1.71 million fewer cases of overweight/obesity (95% CI=1.64, 1.77 million). This could avert 352,000 (95% CI=336,200, 367,500) cases of weight-related diseases and gain 1.86 million (95% CI=1.86, 1.87 million) quality-adjusted life years, saving $22.55 billion (95% CI=$22.46, $22.63 billion) in direct medical costs and $25.43 billion (95% CI= $25.25, $25.61 billion) in productivity losses. This would also reduce depression/anxiety symptoms, saving $3.61 billion (95% CI=$3.58, $3.63 billion) in direct medical costs and $28.38 billion (95% CI=$28.20, $28.56 billion) in productivity losses.

Conclusions: This study shows that achieving the *Healthy People 2030* objective could save third-party payers, businesses, and society billions of dollars for each cohort of persons aged 6−17 years, savings that would continue to repeat with each new cohort. This suggests that even if a substantial amount is invested toward this objective, such investments could pay for themselves.

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INTRODUCTION

There is an extensive body of literature demonstrating that engaging in physical activity (PA) has a wide range of short- and long-term health benefits for youth and that sports participation increases PA. For example, youth with overweight and obesity participating in a PA intervention had reduced body mass index (BMI) and decreased blood pressure and low-density lipoprotein cholesterol.[1] Other studies show that physically active children have a better chance of having a healthier adulthood because PA reduces the risk of many chronic diseases.[2,3] Meanwhile, a study of high school sports participants showed that participating in sports resulted in moderate-to-vigorous PA (MVPA) 60% of the time.[4]

For these reasons, *Healthy People 2030* (HP-2030) has included for the first time increasing youth sports participation to 63.3% by 2030. Established in 1980,[5] *Healthy People*, an initiative of the U.S. Department of Health and Human Services (HHS), sets health-promotion and disease-prevention objectives with targets for the nation each decade on the basis of the biggest public health priorities. *Healthy People* added objective PA-12[6] after the National Youth Sports Strategy was released in 2019.[7] This objective is particularly urgent given that youth sports participation has declined from 58.4% in 2016−2017 to 50.7% in 2020−2021 among U.S. youth, in part owing to the coronavirus disease 2019 (COVID-19) pandemic.[6]

Achieving the HP-2030 objective may require investing substantial resources in policies and interventions ranging from expanding existing youth sports programs and building facilities in communities to training coaches and reducing other barriers to participation.[7,8] To know where all of these fall on their lists of national, regional, and local priorities, policymakers may want to better understand the full range of potential health benefits and cost savings that may result from increasing sports participation and achieving the HP-2030 objective to varying degrees. Such information could help a variety of decision makers such as funders, sports league leaders, health officials, school officials, coaches, and parents. This study aimed to develop an agent-based computational model of all persons aged 6−17 years in the U.S. to quantify the potential physical health, mental health, and economic impact of moving closer to the HP-2030 objective.

METHODS

The model for this study is based on the previously described Virtual Population for Obesity Prevention agent-based model.[9−13] It represents a single cohort of U.S. children aged 6−17 years, their growth over time (based on height- and age-based growth charts[14]), physical and mental health outcomes, PA, food consumption (each consuming daily calories to maintain a constant BMI percentile if his/her level of PA was unchanged), and sports participation each day until age 18 years and then annually until their death (Figure 1). Each agent has sociodemographic (age, sex) and clinical (lean tissue mass/fat-free mass, fat tissue mass/fat mass) characteristics.[15]

Agents have an embedded metabolic model specific to their sex, weight, and age, which translates daily caloric intake and expenditure into weight gain or loss.[16,17] This study used publicly available, deidentified data; thus, IRB approval was not required.

Each agent has a probability of participating in sports (Figure 1). Each individual participating in sports engages in this PA in addition to any PA they engage in outside of sports (assumed to be the same regardless of sports participation). This corresponds to a weekly duration of MVPA of 440 minutes (Appendix Table 1, available online).

To determine how to handle compensatory eating (e.g., increased caloric intake in response to increases in caloric expenditure due to PA), a literature search was conducted for studies from 1990 to 2023 using search terms including *compensatory eating, compensatory behaviors, diet, energy intake, PA, exercise*, and *youth sports*, using MEDLINE/PubMed and Google Scholar. Studies reported mixed evidence of compensatory eating in response to exercise. Some studies demonstrated healthier eating associated with sports participation,[18] others found no evidence of compensatory eating,[19,20] and some suggested that some compensatory eating occurs[21,22] but it is highly variable and dependent on the duration and intensity of the exercise. It also varies from person to person, potentially owing to individual physiologic characteristics.[21,22] Therefore, as a conservative estimate, baseline experiments assumed that agents do increase caloric consumption as a result of increased PA (e.g., compensatory eating occurs) by 25%. Sensitivity analyses explored the effect of varying the proportion of calories (0%−75% of those expended) agents consumed in compensatory eating.

Starting at age 13 years, every 2 weeks, each agent has a sports participation− and sex-specific probability of experiencing depression or anxiety symptoms (Appendix Table 1, available online).[23] A regression analysis study conducted on cross-sectional data by Bjerkan et al.[23] found that youth aged 13−19 years had lower probabilities of depression/anxiety when they had regular participation in sports, compared to when they had low participation in sports (e.g., 12% vs 37% for females and

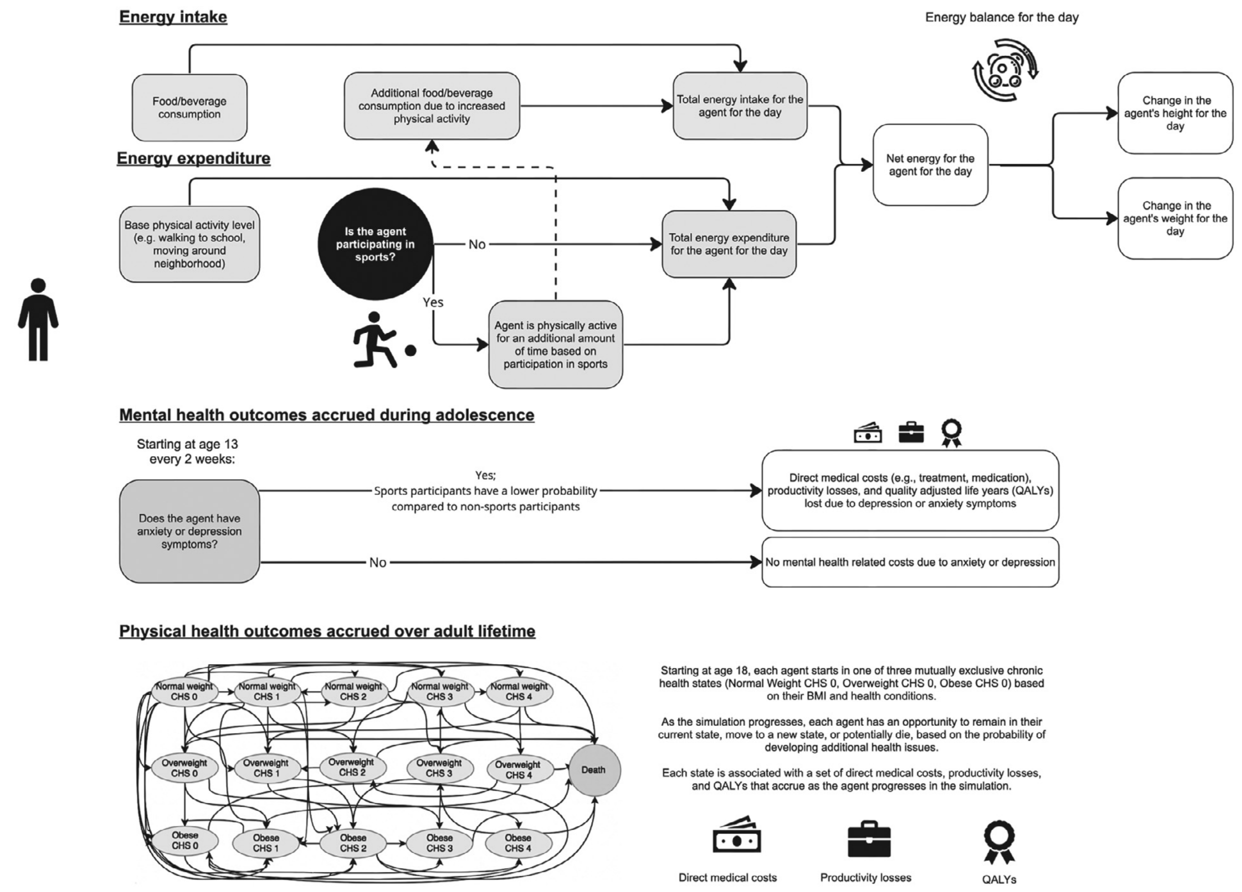

Figure 1. Diagram showing three components of the Virtual Population for Obesity Prevention agent-based model: 1) Metabolic submodel that represents agent's caloric intake and expenditure and the resulting impact 2) Mental health submodel that translates how sports participation may affect mental health 3) Markov submodel that represents the different chronic health states that the agent can be in over the agent's lifetime.

20% vs 41% for males). Because this study only included those aged ≥13 years, to remain conservative about the benefits of PA and sports participation, we did not begin representing the potential impact of sports participation on anxiety and depression risk until youth reach age 13 years. If an agent experiences symptoms, they can experience either anxiety, depression, or a combination of both.[24] Those experiencing symptoms accrue direct medical costs (assuming that 40% seek treatment), productivity losses, and quality-adjusted life-years (QALYs) for their symptom duration (Appendix Table 1, available online). Agents experiencing both depression and anxiety accrue the costs of depression only, to remain conservative.

An embedded Markov model (Figure 1), described in previous publications,[10,12,13,25] determines the physical health outcomes that each agent will experience over time. It consists of 15 mutually exclusive health states that account for both anthropometric measures (e.g., BMI) and the presence and severity of risk factors associated with weight. At age 18 years, agents start at a metabolically healthy state and assume 1 of 3 states on the basis of their BMIs (normal weight, overweight, or obese) at the end of childhood. Each simulated year, the agent has probabilities of staying in the same state or moving to a new state on the basis of state-, age-, and sex-specific probabilities. However, in a given state, the individual has a probability of developing weight-related health outcomes such as type 2 diabetes, coronary heart disease, stroke, and cancers (Appendix Table 1, available online). Individuals accrue state-, health outcome−, and age-specific medical costs, lost productivity, and QALYs.

The third-party payer perspective includes direct medical costs, whereas the societal perspective includes direct medical costs and productivity losses due to absenteeism and presenteeism (i.e., lost productivity that occurs when individuals are absent or not functioning at full capacity owing to a health condition). To calculate productivity losses, the human capital approach was used, where lost productivity is measured by the amount of time by which working life is reduced owing to illness.[26] Each individual's daily wages were multiplied by the proportion of productive time lost owing to his/her specific health condition as follows:

$$\text{Total productivity losses} = \text{daily wage} \times \text{health condition specific proportion of productive timelost} \times \text{duration of outcome in days}$$

To determine this proportion for each health condition, an extensive literature search was conducted in MEDLINE/PubMed and Google Scholar using terms including *absenteeism, presenteeism, productivity, missed work days*, and *disability days*, to find studies that reported productive time lost (due to absenteeism and/or presenteeism) caused by each condition (e.g., diabetes, hypertension) (Appendix Table 1 [available online] presents the studies identified by this literature search). The proportion of productive time lost (Appendix Table 1 [available online] shows all values of time lost owing to each condition) is then the total number of productive days lost in a year divided by the number of work days in a year (assuming 5 days per week, 52 weeks per year).

All individuals accrue productivity losses, regardless of age or employment status, because everyone contributes to society. All costs are reported in 2023 values.

Different simulation experiments explored the impact of increasing youth sports participation in the U.S. to varying degrees, ranging from the most recent levels of youth sports participation in 2020−2021 during the COVID-19 pandemic (50.7%)[6] to 51.7%, 53.85% (25% progress toward HP-2030 target), 58.4% (participation level in 2016−2017, when the HP-2030 baseline was established), and to 63.3% (HP-2030 target). Sensitivity analyses varied the duration of time sports participants engaged in MVPA (±20%), compensatory eating (e.g., consuming 0%−75% of calories expended during sports in addition to normal intake), the degree to which sports participation reduces the probability of depression/anxiety symptoms, and the proportion of those experiencing depression/anxiety symptoms seeking treatment (20%−60%). Given that youth may not always continue playing sports throughout their adolescence, sensitivity analyses explored what happened when different youth participated in sports each year while maintaining the target participation, representing youth starting and stopping playing sports at different ages.

RESULTS

Table 1 shows how increasing the proportion of youth participating in sports reduces weight-related physical and mental health outcomes when meeting the HP-2030 sports participation target to varying degrees. For example, achieving the HP-2030 target of 63.3% decreases overweight and obesity prevalence by an absolute 3.37% (95% CI=3.35%, 3.39%). Even if the U.S. does not meet the HP-2030 target but meets pre−COVID-19 levels (58.4%), overweight and obesity prevalence decreases by an absolute 2.06% (95% CI=2.05%, 2.08%). When youth sports participation increases by just 1% (to 51.7%), there are 136,000 (95% CI=134,000−138,000) fewer youth with overweight and obesity, corresponding to 0.27% of the youth population. When decreasing the duration sports participants are getting MVPA each week by 20% (average of 352 minutes per week), increasing participation to 63.3% still results in an absolute 2.54% (95% CI=2.52%, 2.56%) reduction in overweight and obesity prevalence. Increasing the duration that participants are getting MVPA by 20% (average of 528 minutes per week) results in an absolute 3.66% (95% CI=3.64%, 3.68%) reduction in overweight and obesity prevalence, which translates to 1.851 (95% CI=1.845, 1.858) million fewer individuals with overweight/obesity.

When accounting for the possibility of increased compensatory eating among sports participants, such that they consumed back 50% of the calories expended during sports, overweight and obesity prevalence decreases by an absolute 1.94% (95% CI=1.92%, 1.96%) when meeting the HP-2030 target. Sensitivity analyses demonstrated that when sports participants consumed back 0% and 75% of the calories expended, overweight and obesity prevalence decreases by an absolute 4.18% (95% CI=4.16%, 4.20%) and 1.03% (95% CI=1.01%, 1.05%), respectively.

Regarding the economic impact of reaching the HP-2030 sports participation target due to changes in physical health, Figure 2A shows that increasing sports participation to meet the HP-2030 target to varying degrees saves billions in direct medical costs and productivity losses. For example, reaching the 63.3% target saves $22.55 (95% CI=$22.46, $22.63) billion in direct medical costs and $25.43 (95% CI=$25.25, $25.61) billion in productivity losses owing to improvements in physical health. If instead, the U.S. increases sports participation back to the pre−COVID-19 levels (58.4%), this saves $13.78 (95% CI=$13.71, $13.86) billion and $29.17 (95% CI=$28.99, $29.34) billion from direct medical cost savings and societal cost savings (the sum of direct medical cost savings and productivity loss savings) owing to

Table 1. Physical Health Outcomes Accrued When Meeting the HP-2030 Sports Participation Objective to Varying Degrees

Percentage of U.S. youth participating in sports	Number and proportion of CHD events averted Events (95% CIs) proportion	Number and proportion of type 2 diabetes Cases (95% CIs) proportion	Number and proportion of cancer cases averted Cases (95% CIs) proportion	Number and proportion of stroke cases averted Cases (95% CIs) proportion[a]	Number and proportion of QALYs gained (physical health) QALYs (95% CIs) proportion	Number of QALYs gained (mental health) QALYs (95% CIs)[b]	Number and proportion of years of life saved Years (95% CIs) proportion	Number and proportion of fewer youth with overweight Cases (95% CIs) proportion	Number and proportion of fewer youth with obesity Cases (95% CIs) proportion
51.7% (1% increase)	11,400 (10,600 to 12,300) 0.07%	11,100 (10,500 to 11,800) 0.06%	5,500 (4,500 to 6,500) 0.02%	−320 (−800 to 160) −0.01%	100,000 (94,900 to 105,100) 0.01%	50,200 (47,000 to 53,400)	32,800 (4,500 to 61,100) 0.001%	38,400 (37,000 to 39,800) 0.47%	97,200 (96,000 to 98,400) 1.00%
53.85% (3.15% increase)	35,700 (34,800 to 36,600) 0.23%	36,700 (36,000 to 37,400) 0.20%	14,500 (13,500 to 15,400) 0.04%	−573 (−1,060 to −90) −0.01%	300,600 (295,600 to 305,700) 0.03%	160,200 (157,200 to 163,300)	204,600 (175,600 to 233,700) 0.006%	120,200 (117,400 to 123,000) 1.47%	305,500 (303,400 to 307,600) 3.13%
58.4% (7.7% increase)	88,700 (87,800 to 89,600) 0.57%	89,000 (88,200 to 89,800) 0.48%	36,500 (35,600 to 37,500) 0.11%	64 (−455 to 584) 0.002%	751,100 (745,300 to 756,800) 0.06%	390,900 (387,900 to 393,800)	458,400 (430,000 to 486,800) 0.013%	296,500 (292,700 to 300,400) 3.63%	748,200 (744,700 to 751,700) 7.67%
63.3% (12.6% increase)	145,300 (144,300 to 146,200) 0.93%	146,900 (146,200 to 147,700) 0.80%	59,700 (58,700 to 60,700) 0.18%	419 (−117 to 955) 0.01%	1,222,400 (1,216,600 to 1,228,300) 0.10%	641,400 (638,400 to 644,400)	776,800 (746,700 to 807,000) 0.023%	480,200 (475,000 to 485,400) 5.89%	1,225,900 (1,221,500 to 1,230,200) 12.56%

Note: Outcomes are total over all U.S. children aged 6–17 years lifetime.
[a]The increases in stroke cases are due to individuals living longer and therefore being more likely to develop certain health outcomes.
[b]On the basis of the data available, this study only modeled the change in mental health QALYs.
CHD, coronary heart disease; HP-2030, *Healthy People 2030*; QALY, quality-adjusted life-year.

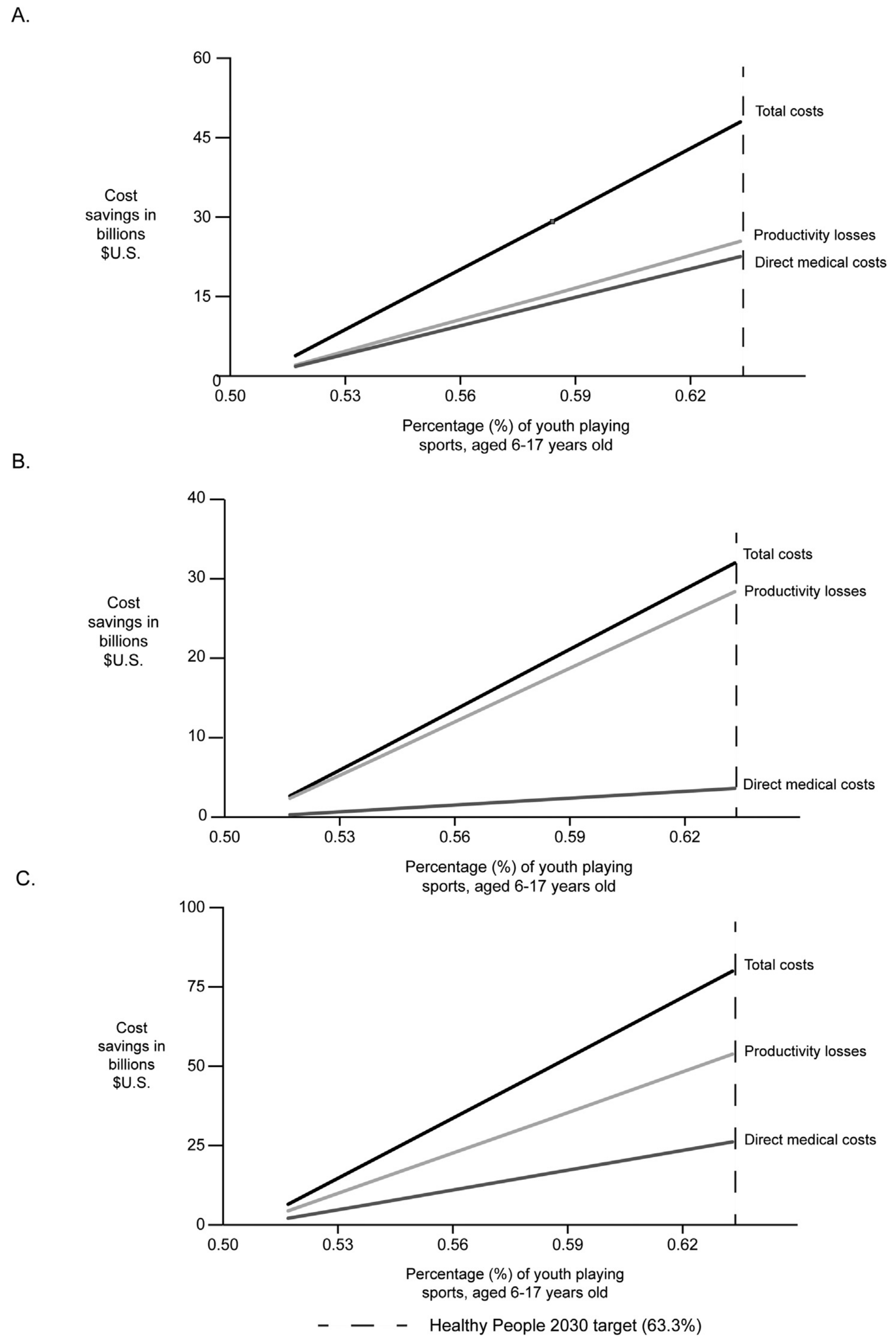

Figure 2. Physical and mental health cost savings from increasing youth sports participation in the U.S.

(A) Physical health cost savings from increasing youth sports participation levels compared with the current level (50.7%) for 1 cohort of persons aged 6−17 years in the U.S. (B) Mental health cost savings from increasing youth sports participation levels compared with the current level (50.7%) for 1 cohort of persons aged 6−17 years in the U.S. (C) Total cost savings gained every 12 years from increasing youth sports participation levels compared with the current level (50.7%) for 1 cohort of persons aged 6−17 years in the U.S.

physical health benefits over participants' lifetime. If the U.S. only increases participation to 51.7% (1% absolute increase), this saves $1.79 (95% CI=$1.74, $1.85) billion and $3.83 (95% CI=$3.66, $4.00) billion from direct medical cost savings and societal cost savings, respectively, owing to physical health benefits over participants' lifetime. Decreasing the weekly duration that sports participants are getting MVPA by 20% still saves $20.20 (95% CI=$20.13, $20.27) billion in direct medical costs and $22.85 (95% CI=$22.69, $23.01) billion in productivity losses; increasing the time spent in MVPA by 20% results in a 4.5% increase in physical health−related cost savings ($23.46 [95% CI=$23.38, $23.54] billion in direct medical costs and 26.50 [95% CI=$26.33, $26.67] billion in productivity losses) when meeting the HP-2030 objective.

Meeting the 63.3% target and assuming that sports participants consumed back 50% of calories expended during sports practice/games saves $18.48 (95% CI= $18.40, $18.54) billion in direct medical costs and $20.9 (95% CI=$20.8, $21.1) billion in productivity losses. When consuming 0% and 75% of the calories expended, cost savings are linearly related to compensatory eating, resulting in savings of $24.87 (95% CI=$24.79, $24.95) billion and $11.37 (95% CI=$11.30, $11.44) billion in direct medical and savings of $28.14 (95% CI=$27.97, $28.30) billion and $13.09 (95% CI=$12.93, $13.26) billion in productivity losses, respectively.

Sensitivity analyses demonstrated that having youth starting and stopping sports participation at different ages increases the societal cost savings associated with reaching the HP-2030 target by 36%, up to $65.17 (95% CI=$64.98, $65.37) billion. This is because the overall total number of youth participating is higher (than when the same youth participate throughout their adolescence). Because the biggest reductions in adverse health outcomes and associated costs occur among new participants, there are greater savings when more youth participate at some point between ages 6 and 17 years, even if for a shorter duration. Conversely, when youth continue playing sports until they are aged 17 years, not as many new individuals benefit from playing sports.

As for the mental health impact of reaching the HP-2030 sports participation target, Table 1 shows the impact of increasing sports participation to varying degrees on QALYs gained owing to reductions in depression and anxiety symptoms. When reducing the impact of sports on mental health outcomes, such that participants are only 5% less likely to have these outcomes than nonparticipants, there are still 139,800 (95% CI=136,700−142,900) QALYs gained. QALYs gained decrease linearly as the probability of depression/anxiety symptoms among sports participants increases (and sports participation reduces mental health outcomes to a lesser extent).

Figure 2B shows that reduction in depression and anxiety symptoms from achieving the HP-2030 sports participation target saves $3.61 (95% CI=$3.58, $3.63) billion in direct medical costs and $28.38 (95% CI= $28.20, $28.56) billion in productivity losses. However, if the U.S. only reaches pre−COVID-19 levels (58.4%), there are savings of $2.21 (95% CI=$2.19, $2.24) billion in direct medical costs and $17.40 (95% CI=$17.22, $17.57) billion in productivity losses. Increasing sports participation to 51.7% saves $292.6 (95% CI=$268.0, $317.1) million in direct medical costs and $2.37 (95% CI=$2.18, $2.55) billion in productivity losses.

Even diminishing the extent to which sports affect the probability of depression and anxiety by 5% (versus nonparticipation) still saves $6.92 (95% CI=$6.73, $7.10) billion from the societal perspective when meeting the 63.3% target. Again, these cost savings decrease linearly as the degree to which sports affect one's probability of depression/anxiety symptoms decreases.

Varying the proportion who seek treatment for depression/anxiety down to 20% still generates $1.80 (95% CI=$1.79, $1.82) billion in direct medical cost savings. This increases linearly to $5.41 (95% CI=$5.37, $5.45) billion when 60% seek treatment.

Figure 2C shows that achieving the HP-2030 sports participation target saves a total of $26.15 (95% CI= $26.07, $26.24) billion in direct medical costs and $53.81 (95% CI=$53.56, $54.07) billion in productivity losses. Even if the U.S. only increases sports participation to 58.4%, there are still $16.00 (95% CI=$15.92, $16.07) billion in direct medical cost savings and $32.78 (95% CI= $32.54, $33.02) billion in productivity losses averted. Moreover, even if the U.S. increases sports participation to 51.7%, there are still $2.09 (95% CI=$2.02, $2.15) billion and $4.41 (95% CI=$4.16, $4.65) billion in savings in direct medical costs and productivity losses, respectively.

DISCUSSION

The results show that achieving the HP-2030 sports participation target in the U.S. generates a reoccurring savings of up to $80.0 billion for each new cohort of persons aged 6−17 years. For comparison, youth sports in the U.S. in 2017 was estimated to be a $15 billion industry,[7] although the industry would likely grow with an increase in sports participation (e.g., reaching the HP-2030 goal). This appears to be the first study to quantify the potential health and economic impact of setting and achieving a national objective for youth sports participation. Knowing this possible impact is important because achieving HP-2030 will require significant investment and bringing together, incentivizing, and coordinating many different stakeholders ranging from policymakers to health officials to sports league leaders. Prior studies have quantified the health and economic impact of PA among youth. For example, our

2017 study published in *Health Affairs* found that if 50% of those aged 8−11 years were to achieve the Centers for Disease Control and Prevention guidelines for PA, $8.1 billion in direct medical costs and $13.8 billion in lost productivity could be averted.[10] A study in *The Lancet* found that physical inactivity could cost healthcare systems international $53.8 billion worldwide.[27] However, these previous studies specifically covered PA and not sports and focused on physical health outcomes without considering mental health. Moreover, increasing PA is not equivalent to increasing sports participation. Sports participation can bring more MVPA for prolonged periods than walking or other activities.[4] In addition, playing sports may provide a regular and routine opportunity to be physically active during practices and games, keep youth engaged in PA through healthy competition, and offer a support structure of teammates and coaches who may encourage healthy behaviors.[7]

A next step would be to identify different policies and interventions that could help achieve the HP-2030 objective and quantify their value to determine how and which to implement. For example, a study previously evaluated the impact of not only increasing the number of schools that offer physical education classes (which can serve as gateways to sports) but also ensuring that physical education classes keep students physically active.[12] Several initiatives have advanced other methods of increasing sports participation. The Aspen Institute's Project Play developed 8 plays to increase sports participation (e.g., reintroducing free play, revitalizing in-town leagues, designing sports to prioritize the individual's development and improvement[28]). The National Youth Sports Strategy offers approaches (e.g., developing shared use agreements) to provide access to public or private play spaces outside their primary use hours.[7] The 2020−2021 President's Council on Sports, Fitness & Nutrition Science Board emphasized the need to "use creative and evidence-based strategies (e.g., minimize lines, avoid lectures, provide equipment for each participant, empower young people to lead activities) to increase activity levels in youth sport."[29]

Limitations

Models are simplifications of real life and cannot account for every possible factor and possibility. For example, our scenarios assumed that the PA levels of youth outside of sports participation (e.g., walking) would not change substantially by sports participation status. To maintain conservative estimates, this study focused on BMI-related chronic health conditions and did not include other potential outcomes (e.g., osteoporosis). The model also did not factor in other possible indirect effects of sports participation that may positively affect physical health (e.g., improved diets/nutrition, decreased substance use). Similarly, this study limited mental health outcomes to depression or anxiety, even though sports participation could potentially improve academic performance, social skills, emotional regulation, and mood.[30,31] Moreover, this study did not account for the possibility that overcompetitive sports environments could result in negative mental health outcomes. Although the simulated scenarios have certain stated initial assumptions and draw from many different data sources, sensitivity analyses explored the impact of varying these assumptions and inputs.

CONCLUSIONS

This study shows that achieving the HP-2030 objective could save third-party payers, businesses, and society billions of dollars for each cohort of persons aged 6−17 years, savings that would continue to repeat with each new cohort. This suggests that even if a substantial amount is invested toward this objective, such investments could pay for themselves.

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SUPPLEMENTAL MATERIAL

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