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ORIGINAL RESEARCH

Temporal and Spatial Trends of Insufficient Physical Activity on Mortality, Years of Life Lost, and Life Expectancy Due to Noncommunicable Diseases in Argentina

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Background: This study estimates the spatial distribution and trends in preventable deaths, years of life lost (YLL), and life expectancy (LE), associated with noncommunicable diseases attributable to insufficient physical activity in Argentina under various counterfactual scenarios. **Methods**: Potential impact fractions were used to calculate the preventable deaths and YLL attributable to physical inactivity. Cause-eliminated life tables were used to estimate LE gains, and Monte Carlo simulations were performed for uncertainty analysis. **Results**: From 2005 to 2018, insufficient physical activity was found to be the cause of 7544 to 8220 preventable deaths (≈4.28% of major noncommunicable diseases and ≈2.62% of all causes) and about 221 to 219 YLL per 100,000 inhabitants; between 0.67 and 0.71 years of LE could have been gained. If the World Health Organization recommendations (at least 600 metabolic equivalent tasks minutes per week) had been achieved, between 2813 and 3111 premature deaths could have been prevented, about 80 fewer years of life (per 100,000 inhabitants) would have been lost, and 0.22 years of LE could have been gained. A 15% reduction in insufficient physical activity has shown a small impact on outcomes. **Conclusion**: Public health initiatives must address the physical inactivity epidemic to improve noncommunicable diseases prevention strategies in Argentina.

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Keywords: epidemiology, physical inactivity

Around the world, noncommunicable diseases (NCDs) are responsible for an estimated 41 million deaths annually, representing 71% of all deaths.[1] Low- and middle-income countries bear a disproportionate burden of NCDs: individuals living in developing countries face 1.5 times higher risk of premature death from NCDs.[2] For example, in a middle-income country such as Argentina, which has the second-highest population in South America, NCDs are responsible for 73.4% of deaths, 52% of years of life lost (YLL), and 76% of disability-adjusted life years.[3]

Insufficient physical activity (ie, <600 metabolic equivalent tasks minute per week [METs min·wk^{-1}]) has been recognized as a global pandemic and its role in the development of major NCDs is widely acknowledged.[4,5] Extensive scientific evidence has confirmed the association between insufficient physical activity and increased risk for colon cancer,[6] breast cancer,[7] coronary heart disease,[8] ischemic stroke,[9] and type 2 diabetes.[10] Previous studies have also quantified that the burden of disease for NCDs associated with physical inactivity is approximately 36% for coronary and ischemic heart diseases (IHD), 20% for colon and breast cancers, and 7% for type 2 diabetes.[4,11] Insufficient physical activity is also associated with shorter life expectancy (LE) and more YLL.[12–14]

In May 2012, the World Health Organization (WHO) launched a Global Action Plan (the so-called "25 × 25 target") aimed at reducing NCDs by 25% by 2025 (relative to each country's baseline). Among its 9 global targets was the aim to reduce insufficient physical activity by 10%.[15] In 2018, a 5-year extension of the 2025 target was proposed, with an additional 5% increase, using a baseline of 2016.[16] At present, however, little is known about the impact that meeting this goal could have on deaths from NCDs in Argentina.

Some studies have assessed the impact of physical inactivity on preventable deaths (PDs),[17] YLL,[18] and LE[12] in conjunction with different NCDs in developing countries, but to the best of our knowledge only one study has estimated mortality from cardiovascular diseases attributable to physical inactivity in Argentina.[19] Furthermore, to date there has been no comprehensive assessment quantifying national and subnational variations in NCDs over time. Thus, a better understanding and awareness of the heterogeneity of the burden of physical inactivity and its consequences at subnational levels over time are needed to identify the most vulnerable populations and support the optimal allocation of resources to physical activity promotion policies in Argentina.

This study also contributes to the international literature by estimating 3 indicators for measuring the impact of insufficient physical activity on public health due to NCD deaths. First, PDs were computed using potential impact fractions (PIFs) based on risk ratios (RRs) and uncertainty was addressed using sensitivity analyses to estimate robust and transparent results. Second, life tables were generated without assuming a stationary population (ie, population constant over time) to quantify potential gains in LE, representing added years of LE resulting from partial and complete eliminations of insufficient physical activity; these tables are particularly useful for estimating the burden of disease and setting priorities for health planning.[20] Finally, potential YLLs were computed from the life tables developed. This measure was developed by the Global Burden of Disease study, and from an economic and health policy perspective it is a useful analytical tool for measuring preventable loss of life. It is also useful when combined with strategies used in cost-benefit analyses, such as time-based discounting. Age-standardized YLL was used to compare results across populations[21] because it is a useful measure for

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identifying demographic or state subgroups with the highest premature mortality rate.[22]

This study thus has 2 purposes—first, to quantify PDs and gains in LE and YLL due to NCDs resulting from insufficient physical activity in Argentina at the national and subnational levels from 2005 to 2018, and second, to estimate the shifts in the aforementioned indicators by reducing this risk factor in different counterfactual scenarios: (1) to theoretical minimum risk exposure levels (TMREL), (2) to at least 600 METs min·wk^{-1}, and (3) reducing insufficient physical activity by 15% (WHO 2030 target).

Methods

Input Data

Insufficient Physical Activity Exposure Data. Data from the 2005, 2009, 2013, and 2018 (n = 41,392; 34,732; 32,365; and 29,224) National Risk Factor Surveys were used in this paper (for open access, visit https://www.indec.gob.ar/bases-de-datos.asp). These are face-to-face surveys administered nationally using a multistage probability sample and the national urban sampling framework. The target population comprises persons aged 18 years and older living in urban areas with at least 5000 inhabitants. The National Risk Factor Surveys contain a specific module in which a questionnaire was used to collect information on the amount of physical activity performed by an individual. This module breaks down 3 physical activity levels—intense, moderate, and walking—following the criteria established in the International Physical Activity Questionnaire-Short Form (IPAQ-SF). The survey included the following questions. Concerning the intensity of an individual's activity level, respondents were asked: (1) "in the last week, how many days did you do intense physical activities for at least 10 minutes?" and (2) "[what was your] intense physical activity time in minutes?" Those whose physical activity was moderate were asked: (1) "in the last week, how many days did you do moderate physical activities for at least 10 minutes?" and (2) "[what was your] moderate physical activity time in minutes?" Those whose physical activity level was low were asked: (1) "in the last week, how many days did you walk for at least 10 minutes?" and (2) "[what was your] walking time in minutes?" The MET of the task values derived from the IPAQ-SF reliability study were used to assign a value to each level of physical activity: walking represented 3.3 METs, moderate activity represented 4 METs, and intense activity represented 8 METs.[23] The total METs min·wk^{-1} were calculated as walking $(3.3 \times \text{min} \times \text{d})$ + moderate $(4.0 \times \text{min} \times \text{d})$ + intense $(8.0 \times \text{min} \times \text{d})$ by summing up the METs min·wk^{-1} across each level. To ensure that the sampling distribution was nationally representative, the estimates were weighted by the expansion factor provided by the National Risk Factor Surveys. To ensure consistency with the other data resources, only adults aged 25 to >79 years who responded to the physical activity questionnaire were used. As the IPAQ-SF may not reliably measure physical activity among people aged 70 years and older, data from participants in the 70–74, 75–79, and >79 years age groups were combined with those in the 65–69 years age group, and the same prevalence values were used for them.[12] Following IPAQ-SF guidelines, all cases reporting more than 960 minutes per day of physical activity between walking and moderate, to vigorous physical activity were excluded. Finally, time spent walking and moderate to vigorous activity were truncated at 180 minutes per day.[24]

Relative Risk Data. Relative risks and 95% confidence intervals for colon and breast cancer, IHD, ischemic stroke, and type 2 diabetes (Supplementary Table S1 [available online]) were retrieved from a recent dose–response meta-analysis for prospective cohort studies.[25] All of these data were classified into 4 levels of physical activity according to the following cutoff points: <600, 600 to 3999, 4000 to 7999, and ≥8000 METs min·wk^{-1}[11] for all ages combined and both genders (except for breast cancer). The category ≥8000 METs min·wk^{-1} was then selected as the benchmark for the TMREL, which assumes that there are no additional benefits of physical activity associated with a reduced risk of NCDs.[17]

Death Data. Data on premature deaths (25 to >79 years of age) from 2005 to 2018 were collected from the vital statistics database developed by the National Directorate of Health Statistics and Information and classified according to underlying cause, age, and gender.[26] We used what was defined by the 10th revision of the International Statistical Classification of Diseases (ICD-10) to classify premature deaths by underlying cause: IHD (ICD I20–I25), stroke (ICD G45 and I64), breast cancer (ICD C50) for women and colon cancer (ICD C18), and diabetes mellitus (ICD E11, E14). Data consistency was assessed by cross-checking the number of deaths with the official statistics aggregated at the province-age level.[27] No statistically significant differences were found. Q3

Population Data. Population data were obtained from the 2001 and 2010 censuses.[28,29] Linear interpolation was used to obtain the data for the period 2005–2018 by assuming a constant intraperiod annual population growth rate.

Statistical Analysis

Calculation of Potential Impact Fractions and PDs. The PIFs were calculated using the following equation:

$$\text{PIF}^{i}_{a,g,p,t,s} = \frac{\sum_{l=1}^{n}(p_{l,a,g,p,t})(\text{RR}^{i}_{l}) - \sum_{l=1}^{n}(p'_{l,a,g,p,t,s})(\text{RR}^{i}_{l})}{\sum_{l=1}^{n}(p_{l,a,g,p,t})(\text{RR}^{i}_{l})}, \quad (1)$$

where $p_{l,a,g,p,t,s}$ is the proportion of the population at level l of physical activity, $p'_{l,a,g,p,t,s}$ is the proportion of the population at level l who engage in physical activity in the counterfactual scenario, and RR^{i}_{l} is the relative risk of each cause i (IHD, stroke, breast cancer, colon cancer, and diabetes) at level l of physical activity. Levels l of physical activity were set at <600, 600 to 3999, 4000 to 7999, and ≥8000 METs min·wk^{-1}. The following counterfactual scenarios were used:

1. TMREL: all persons who achieved at least 8000 METs min·wk^{-1}. The PIF estimates related to this scenario will hereafter be referred to as the population attributable fraction (PAF), a special case of PIF in which exposure is eliminated.[30,31]
2. Physical activity recommendation: all persons who achieved at least 600 METs min·wk^{-1}.[32]
3. WHO 2030 target: those who were able to reduce their insufficient physical activity (<600 METs min·wk^{-1}) by 15%.[16]

Once PIFs were estimated, PDs ($\text{PD}^{i}_{a,g,p,t,s}$) were computed as:

$$\text{PD}^{i}_{a,g,p,t,s} = (\text{PIF}^{i}_{a,g,p,t,s})(D^{i}_{a,g,p,t}), \quad (2)$$

where $D^{i}_{a,g,p,t}$ is the number of observed deaths. Age-standardized PD rates per 100,000 inhabitants to the whole risk factor were then calculated by dividing $\mathrm{PD}^{i}_{a,g,p,t,s}$ by the age-specific population at the provincial level. All specific $\mathrm{PIF}^{i}_{a,g,p,t,s}$ and $\mathrm{PD}^{i}_{a,g,p,t,s}$ were computed by age group (a), gender (g), province (p), year (t), cause (i), and counterfactual scenario (s).

Gains in Life Expectancy. Gains in LE attributable to reduced physical inactivity were estimated using a cause-eliminated life table analysis, which estimates the years of life gained if deaths from a specific cause are removed from current mortality rates.[33] For this purpose, the PIFs calculated for the different scenarios were used to reduce the mortality rates in the life tables and LE was recalculated from the new mortality rates. To calculate gains in LE, it was necessary to construct specific life tables by applying standard life table techniques[34] using the observed mortality in Argentina for each age interval, gender, province, and year. The first step was to calculate survival probabilities (${}_{n}p_{x,g,p,t}$) from observed all-cause mortality using the following equation:

$$ {}_{n}p_{x,g,p,t} = \begin{cases} 1 - {}_{n}q_{x,g,p,t} & \text{if } x \leq 79 \\ 0 & \text{if } x > 79 \end{cases}, \tag{3} $$

where x denotes the exact age, n is the number of years in the age interval, and ${}_{n}q_{x,g,p,t}$ is the probability of dying during that age interval and was computed as:

$$ {}_{n}q_{x,g,p,t} = \begin{cases} 1 - \exp^{(-n)({}_{n}m_{x,g,p,t})} & \text{if } x \leq 79 \\ 1 & \text{if } x > 79 \end{cases}, \tag{4} $$

where ${}_{n}m_{x,g,p,t}$ is the observed mortality for all causes. The number of people who had survived at the beginning of each age interval was then calculated as follows:

$$ l_{(x+n),g,p,t} = (l_{x,g,p,t})({}_{n}p_{x,g,p,t}), \tag{5} $$

where $l_{x,g,p,t} = 100{,}000$ at the beginning of the first age interval. The number of person-years in an age interval from x to $x+n$ was computed as:

$$ {}_{n}L_{x,g,p,t} = \frac{{}_{n}d_{x,g,p,t}}{{}_{n}m_{x,g,p,t}}, \tag{6} $$

where ${}_{n}d_{x,g,p,t} = l_{x,g,p,t} - l_{(x+n),g,p,t}$. Finally, ($e_{x,g,p,t}$) was calculated using the following equation:

$$ e_{x,g,p,t} = \frac{T_{x,g,p,t}}{l_{x,g,p,t}}, \tag{7} $$

where $T_{x,g,p,t} = \sum_{x=25}^{>79} {}_{n}L_{x,g,p,t}$. Once the life tables were calculated using the observed mortality rates, the mortality rates that would be expected for exposure to each risk factor proposed in the counterfactual scenarios were computed. First, the probabilities of dying were estimated by partially eliminating the i_{th} cause of death:

$$ {}^{*}_{n}q^{-i}_{x,g,p,t,s} = 1 - {}_{n}p_{x,g,p,t,s}^{\left[\frac{{}_{n}D_{x,g,p,t} - ({}_{n}D^{i}_{x,g,p,t})(\mathrm{PIF}^{i}_{a,g,p,t,s})}{{}_{n}D_{x,g,p,t}}\right]}, \tag{8} $$

where ${}_{n}D_{x,g,p,t}$ is the number of deaths from all causes and ${}_{n}D^{i}_{x,g,p,t}$ is the number of deaths attributable to the i_{th} cause of death. The net probability of death formula was modified by including an improvement factor to reduce the impact of a cause of death rather than completely eliminating it.[35] This improvement factor is represented by $\mathrm{PIF}^{i}_{a,g,p,t,s}$ and allows for partial elimination of risk attributable to the alternative distribution of physical inactivity associated with cause of death i. Subsequently, the cause-eliminated LE was calculated as:

$$ {}^{*}e^{-i}_{x,g,p,t,s} = \frac{{}^{*}T^{-i}_{x,g,p,t,s}}{{}^{*}l^{-i}_{x,g,p,t,s}}, \tag{9} $$

where ${}^{*}T^{-i}_{x,g,p,t,s}$ is the number of person-years lived after exact age x and ${}^{*}l^{-i}_{x,g,p,t,s}$ is the number of survivors, both due to the i_{th} causes of death. Finally, potential gains in LE from the partial elimination of physical inactivity in different scenarios associated with the cause of death i were calculated as the difference between cause-eliminated LE and LE:

$$ \mathrm{PGLE}^{-i}_{x,g,p,t,s} = {}^{*}e^{-i}_{x,g,p,t,s} - e_{x,g,p,t}. \tag{10} $$

To identify potential gains in LE in all age groups, the LE between the age intervals 25–29 and >79 years was calculated as:

$$ e_{(25\text{–}29,>79),g,p,t} = \frac{T_{(25\text{–}29),g,p,t} - T_{(>79),g,p,t}}{l_{(25\text{–}29),g,p,t}}, \tag{11} $$

where $T_{(25\text{–}29),g,p,t} - T_{(>79),g,p,t}$ is the number of person-years lived between the age intervals 25–29 to >79 years, and $l_{(25\text{–}29),g,p,t}$ is the number of survivors in the age interval 25–29 years in the life tables. Similarly, LE was estimated after partial elimination of a particular cause of death. Finally, total gains in LE were expressed as the differences between partially cause-eliminated LE and LE for the population aged 25–29 to >79 years.

Estimating Years of Life Lost. The YLLs were calculated to summarize the PDs associated with the alternative distributions of physical activity using the cause-eliminated LE by incorporating discounts and age weighting[36]:

$$ {}_{n}\mathrm{YLL}^{i}_{x,g,p,t,s} = ({}_{n}D^{i}_{x,g,p,t}) \left[\frac{KC\exp^{r({}_{n}a_{x})}}{(r+\beta)^{2}} \begin{pmatrix} \exp^{z}[z-1] - \\ \exp^{-(r+\beta){}_{n}a_{x}}[-(r+\beta){}_{n}a_{x} - 1] \end{pmatrix} + \frac{1-K}{r}\left(1 - \exp^{r({}^{*}e^{-i}_{x,g,p,t,s})}\right) \right], \tag{12} $$

where $z = -(r+\beta)({}^{*}e^{-i}_{x,g,p,t,s} + {}_{n}a_{x})$. For this equation, s is the discount rate and C and K are age-weighting constants (a complete overview of notation and parameter settings can be found in Supplementary Table S2 [available online]). YLL rates per 100,000 inhabitants were then estimated for cross-population comparisons. However, YLL rates for all ages were not appropriate for comparison across population groups and over time, as they were not adjusted for the age structure of the population. Thus, the age-standardized YLL rates were calculated by applying the direct age-standardization method[37]:

$$ \mathrm{ASYLL\ rates}^{i}_{g,p,t,s} = \sum_{x=25}^{>79} ({}_{n}w_{x,g,p,t})({}_{n}\mathrm{YLL\ rates}^{i}_{x,g,p,t,s}), \tag{13} $$

where ${}_{n}w_{x,g,p,t}$ is the population weighting. To summarize changes over time, average annual changes in percentage points were computed for all estimates.

Sensitivity Analysis. Sensitivity analyses were performed using the lower and upper limits of 95% confidence intervals for RR estimates as input variables and PIFs, PDs, YLLs, and gains in LEs as output variables. A log-normal distribution was specified for RR. Ninety-five percent uncertainty intervals (UIs) were calculated bound by the 2.5th and 97.5th of the 25,000 Monte Carlo simulations performed.

All analyses were performed using Stata (version 15.0; StataCorp LP, College Station, TX) and RStudio (version 1.4.1106; RStudio Inc, Boston, MA). Data and codes for replication can be found at https://osf.io/gfmk7/?view_only=0c0d78c00b5e4e63939c541c8073732e.

Results

From 2005 to 2018, slightly more than a third and up to approximately half of Argentina's adult population did not meet the WHO recommendation of 600 METs min·wk^{-1}; in this cohort, women outnumbered men. Physical inactivity among this population increased by 4.67% for both genders, 3.08% for men and 6.02% for women. Less than 8% of the reference group used in the scenario representing the TMREL performed ≥8000 METs min·wk^{-1}. The percentage of people who achieved ≥8000 METs min·wk^{-1} decreased 6.43% in men and 11.46% in women (Supplementary Table S3 [available online]). Significant spatial heterogeneity was found among the subnational levels. The average annual change in the percentage of people who achieved <600 METs min·wk^{-1} at the provincial level ranged significantly from −7.78% to 56.52% (Supplementary Table S4 [available online]). By reducing their insufficient physical activity by 15%, the percentage of adults achieving <600 METs min·wk^{-1} would have changed from 36.96% to 41.18% (35.63%–38.02% of men, 38.11%–44.02% of women) to 31.42% to 35.00% (30.29%–32.32% of men, 32.40%–37.42% of women) between 2005 and 2018 (Supplementary Table S3 [available online]).

Table 1 presents the numbers of PDs for all scenarios by outcome and gender from 2005 to 2018. These data indicate a positive average annual change for colon and breast cancer (5.15%, 3.31%), IHD (4.83%), and diabetes (1.54%). In the TMREL scenario (panel A), it was estimated that about 7544 (95% UI, 6378–8677) to 8220 (95% UI, 6945–9454) PDs from NCDs could have been avoided from 2005 to 2018 if population-wide physical activity had increased. Estimates ranged from about 596 (95% UI, 463–728) to 676 (95% UI, 522–829) PDs from breast cancer and 2671 (95% UI, 2440–2904) to 3204 (95% UI, 2932–3481) PDs from IHD between 2005 and 2018, respectively. PDs from colon cancer, breast cancer, IHD, stroke, and diabetes from 2005 to 2018 accounted for approximately 0.52% to 0.58%, 0.34% to 0.35%, 1.50% to 1.68%, 0.94% to 0.75%, and 0.95% to 0.93%, respectively, of deaths from major NCDs and 0.34% to 0.35%, 0.22% to 0.21%, 0.98% to 1.00%, 0.62% to 0.45%, 0.62% to 0.56%, respectively, of deaths from all causes.

Figure 1 illustrates the number of PDs attributable to the TMREL scenario across all outcomes, age groups, and genders. PDs were generally highest from 45 to 49 years for men and 70 to 74 years for women, with a significant increase in deaths from IHD in older age groups from 2005 to 2018. Spatial heterogeneity was also found between 2005 and 2018 for both men and women between ±30 PDs (age-standardized PD rates per 100,000 inhabitants).

Age-standardized YLL rates (per 100,000 inhabitants) in the TMREL scenario ranged from 27.70 (95% UI, 19.99–34.53) to 31.16 (95% UI, 22.49–38.70) years for colon cancer and 76.07 (95% UI, 69.42–82.76) to 82.32 (95% UI, 75.29–89.47) years for IHD from 2005 to 2018, respectively (Table 2, panel A). In total, physical inactivity accounted for 221.46 (95% UI, 186.05–255.94) to 219.84 (95% UI, 184.39–254.18) YLL from 2005 to 2018 in the same scenario. The age-specific YLL rates (per 100,000 inhabitants) for men and women have increased markedly from 40 to 44 years to >79 years for all causes of death, with a decreasing time trend from 2005 to 2018 more pronounced for women (Figure 2).

In the same scenario, from 2005 to 2018, LE would have increased by 0.09 (95% UI, 0.06–0.11) to 0.11 (95% UI, 0.08–0.14) years for the colon cancer outcome, and 0.26 (95% UI, 0.20–0.32) to 0.28 (95% UI, 0.22–0.34) years for the breast cancer outcome. For all causes and both genders, the LE gained would have been between 0.67 (95% UI, 0.55–0.78) and 0.71 (95% UI, 0.58–0.83) years from 2005 to 2018, respectively (Table 3, panel A). LE gained across age groups, genders, and causes peaked for men diagnosed with IHD and women diagnosed with breast cancer, both in the 25–29 age group. From there, a decline began for both of these cohorts, with a greater gradient for breast cancer patients starting in the 45–49 age group. The overall time trend pattern was equal for all years. The differences in LE gained between 2018 and 2005 were between −0.4 and 0.6 years, with significant regional differences between men and women (Figure 3).

If the WHO physical activity recommendations had been met from 2005 to 2018, 2813 (95% UI, 1516–4133) to 3111 (95% UI, 1660–4586) deaths could have been avoided (Table 1, panel B), corresponding to 1.58% to 1.63% of deaths due to major NCDs and 1.03% to 0.98% for all age groups, genders, and causes of death. Approximately 79.80 (95% UI, 41.50–119.01) to 80.73 (95% UI, 41.12–121.21) fewer years of life would have been lost and 0.21 (95% UI, 0.10–0.34) to 0.23 (95% UI, 0.10–0.37) years of LE would have been gained (Table 3, panel B).

Meeting the 15% reduction target for insufficient physical activity could have prevented a total of 426 (95% UI, 216–641) to 471 (95% UI, 244–701) deaths, which is <0.16% of all causes of deaths. Approximately 12.04 (95% UI, 5.94–18.27) to 12.16 (95% UI, 6.05–18.41) fewer years of life would have been lost (Table 2, panel C), and nearly 0.032 (95% UI, 0.014–0.050) to 0.034 (95% UI, 0.014–0.055) years of LE would have been gained (Table 3, panel C).

No significance was found for colon and breast cancer ($P > .05$) in any health metrics for both WHO physical activity recommendations and the 2030 target.

Discussion

To the best of our knowledge, this paper is the first to estimate the impact of physical inactivity on PDs, YLL, and LE due to NCDs (breast and colon cancer, IHD, stroke, and type 2 diabetes) over time by disaggregating jointly by province, outcome, age, and gender. This approach allowed us to explore the heterogeneity of our results to better understand the patterns of this complex relationship, which is especially useful for setting priorities in stratified health planning by identifying the most vulnerable target populations.

The prevalence of physical inactivity in Argentina has increased significantly in recent years (Supplementary Table S1 [available online]). As the current study results indicate, physical inactivity contributes to a significant percentage of NCD deaths. From 2005 to 2018, insufficient physical activity accounted for 7544 to 8220 PDs (≈4.28% of major NCDs and ≈2.62% of all causes), approximately 221 to 219 YLL per 100,000 inhabitants, and between 0.67 and 0.71 years of LE could have been gained. Achieving the WHO recommendations (at least 600 METs min·wk^{-1}) would have prevented 2813 to 3111 premature deaths, saved approximately 80 years of life (per 100,000 inhabitants), and added 0.22 LE years. A 15% reduction in insufficient physical activity has not shown a significant impact on outcomes. These impacts are heterogeneous when stratified by outcome, age group,

Table 1 PDs From NCDs Attributable to Physical Inactivity in Different Counterfactual Scenarios by Year and Gender in Argentina (Among Individuals Aged 25 to >79 y)

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	2005		2009		2013		2018		
Scenario/outcome	PDs (n)	95% UI	PDs (n)	95% UI	PDs (n)	95% UI	PDs (n)	95% UI	Average annual change, %
Panel A. TMREL (≥8000 METs min·wk^{-1})									
Colon cancer[a]									
Both	918	664, 1143	1048	767, 1299	1143	835, 1416	1115	805, 1383	5.15
Men	480	347, 597	547	399, 679	601	440, 746	589	424, 732	5.46
Women	438	317, 546	501	835, 1416	542	395, 671	526	381, 651	4.90
Breast cancer[b]									
Both	NA	NA	NA	NA	NA	NA	NA	NA	
Men	NA	NA	NA	NA	NA	NA	NA	NA	
Women	596	463, 728	659	505, 808	691	528, 852	676	522, 829	3.31
IHD[c]									
Both	2671	2440, 2904	2884	2648, 3125	3262	2996, 3530	3204	2932, 3481	4.83
Men	1619	1476, 1764	1647	1507, 1787	1845	1690, 1999	1817	1656, 1979	3.06
Women	1051	963, 1140	1237	1141, 1338	1417	1306, 1531	1387	1276, 1502	7.53
Stroke[d]									
Both	1675	1491, 1860	1625	1453, 1803	1588	1419, 1760	1441	1283, 1600	−3.63
Men	804	715, 892	739	660, 821	740	661, 822	696	618, 774	−3.47
Women	871	777, 968	886	793, 982	848	758, 939	744	665, 825	−3.71
Diabetes[e]									
Both	1684	1320, 2043	1610	1267, 1959	1723	1358, 2099	1784	1401, 2161	1.54
Men	848	681, 1017	789	635, 945	872	703, 1042	940	752, 1125	2.84
Women	836	639, 1025	821	631, 1015	852	655, 1057	844	649, 1036	0.26
Total									
Both	7544	6378, 8677	7826	6639, 8994	8407	7136, 9658	8220	6945, 9454	2.23
Men	3751	3219, 4270	3722	3201, 4231	4058	3494, 4609	4042	3450, 4610	1.96
Women	3793	3159, 4407	4104	3438, 4763	4349	3642, 5049	4178	3495, 4844	2.56
Panel B. PA recommendation (≥600 METs min·wk^{-1})									
Colon cancer									
Both	225	−48, 498	292	−63, 641	327	−70, 716	279	−59, 615	6.77
Men	120	−25, 266	149	−32, 328	164	−35, 361	142	−30, 314	5.20
Women	105	−22, 232	143	−31, 313	163	−35, 355	137	−29, 301	8.55
Breast cancer									
Both	NA	NA	NA	NA	NA	NA	NA	NA	
Men	NA	NA	NA	NA	NA	NA	NA	NA	
Women	71	−60, 209	101	−83, 294	112	−91, 325	91	−74, 266	8.60
IHD									
Both	1285	1031, 1543	1500	1208, 1796	1723	1389, 2060	1546	1242, 1855	5.33
Men	787	634, 948	847	685, 1017	946	767, 1135	856	691, 1031	2.45

(continued)

Table 1 ***(continued)***

Scenario/outcome	2005 PDs (n)	2005 95% UI	2009 PDs (n)	2009 95% UI	2013 PDs (n)	2013 95% UI	2018 PDs (n)	2018 95% UI	Average annual change, %
Women	498	397, 595	653	523, 779	777	623, 925	691	551, 825	9.76
Stroke									
Both	668	447, 889	724	487, 959	728	491, 964	589	395, 784	–2.54
Men	326	217, 432	321	214, 424	323	216, 428	273	182, 363	–4.10
Women	342	231, 456	403	273, 535	405	275, 536	316	214, 421	–0.91
Diabetes									
Both	564	146, 994	600	156, 1055	657	171, 1152	605	156, 1067	1.99
Men	292	79, 508	291	80, 504	322	88, 556	311	84, 543	1.72
Women	272	67, 486	309	76, 550	335	83, 596	293	72, 524	2.37
Total									
Both	2813	1516, 4133	3217	1706, 4745	3567	1889, 5217	3111	1660, 4586	3.11
Men	1525	904, 2153	1608	947, 2274	1775	1035, 2480	1583	926, 2250	1.25
Women	1288	612, 1980	1609	759, 2471	1792	854, 2737	1528	734, 2336	5.39
Panel C. 15% reduction in insufficient PA[f]									
Colon cancer									
Both	34	–7, 75	44	–9, 96	49	–11, 107	42	–9, 92	6.62
Men	18	–4, 40	22	–5, 49	25	–5, 54	21	–4, 47	4.96
Women	16	–3, 35	21	–5, 47	24	–5, 53	20	–4, 45	7.22
Breast cancer									
Both	NA	NA	NA	NA	NA	NA	NA	NA	
Men	NA	NA	NA	NA	NA	NA	NA	NA	
Women	9	–15, 36	15	–13, 44	16	–14, 49	13	–13, 41	13.65
IHD									
Both	198	149, 248	229	178, 281	261	207, 316	236	183, 291	5.01
Men	124	90, 159	131	99, 164	144	114, 177	133	100, 167	1.98
Women	75	60, 89	98	78, 117	117	93, 139	104	83, 124	9.74
Stroke									
Both	100	67, 133	109	73, 144	109	74, 145	88	59, 118	–2.57
Men	49	33, 65	48	32, 64	48	32, 64	41	27, 54	–4.16
Women	51	35, 68	60	41, 80	61	41, 80	47	32, 63	–0.91
Diabetes									
Both	85	22, 149	90	23, 158	99	26, 173	91	23, 160	1.95
Men	44	12, 76	44	12, 76	48	13, 83	47	13, 81	1.75
Women	41	10, 73	46	11, 83	50	12, 89	44	11, 79	2.22
Total									
Both	426	216, 641	486	252, 724	534	282, 790	471	244, 701	3.04
Men	234	130, 340	245	139, 353	266	154, 379	242	135, 350	1.06
Women	192	86, 301	241	113, 371	268	128, 411	229	109, 351	5.54
Major NCDs[g]									

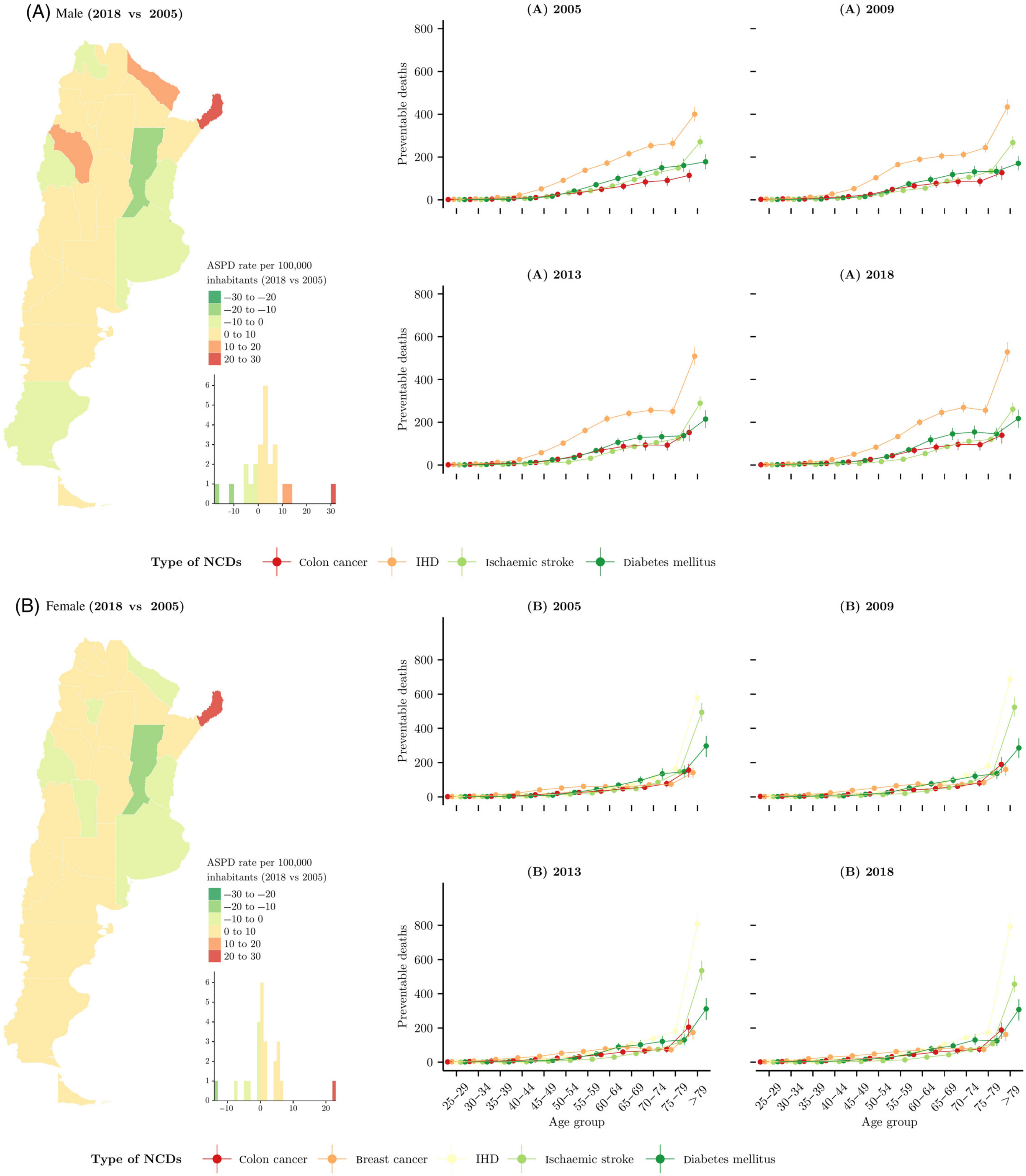
(continued)

Table 1 (continued)

Scenario/outcome	2005 PDs (n)	2005 95% UI	2009 PDs (n)	2009 95% UI	2013 PDs (n)	2013 95% UI	2018 PDs (n)	2018 95% UI	Average annual change, %
Men	91,835		90,908		94,775		97,274		1.47
Women	85,942		87,141		93,069		93,861		2.26
Both	177,777		178,049		187,844		191,135		1.85
All-cause mortality[h]									
Men	143,223		147,241		157,017		163,155		3.34
Women	130,075		136,248		149,729		155,841		4.68
Both	273,298		283,489		306,746		318,996		3.98

Abbreviations: IHD, ischemic heart disease; METs, metabolic equivalent tasks; NA, not applicable; NCDs, noncommunicable diseases; PA, physical activity; PDs, preventable deaths; TMREL, theoretical minimum risk exposure levels; UI, uncertainty interval; WHO, World Health Organization.

The 10th revision of the International Statistical Classification of Diseases (ICD-10) was used to classify premature deaths: [a]colon cancer (ICD C18); [b]breast cancer (ICD C50); [c]IHD (ICD I20–I25); [d]stroke (ICD G45 and I64); [e]diabetes mellitus (ICD E11, E14). [f]Insufficient PA was defined as ≥600 METs min·wk^{-1}. [g]Major NCDs were cancer (ICD C00–C97), cardiovascular diseases (ICD I00–I99), chronic respiratory diseases (ICD J30–J98) and diabetes (ICD E10–E14), dictated by the WHO Global Action Plan for 2025. [h]All-cause mortality (ICD A00–Y89).



Q5 **Figure 1** — Spatial and temporal trends in preventable deaths from NCDs attributable to physical inactivity at the TMREL scenario by year, gender, and age group in Argentina (among individuals aged 25 to >79 y). Note: Panels A and B present spatial changes in the age-standardized preventable deaths rate per 100,000 inhabitants for all outcomes between 2018 and 2005 (left) and preventable death trends (2005, 2009, 2013, and 2018) by age group (right side) for both men and women. ASPD rate indicates age-standardized preventable death rate; IHD, ischemic heart disease; NCDs, noncommunicable diseases; TMREL, theoretical minimum risk exposure levels.

Table 2 Age-Standardized Years of Life Lost From NCDs Attributable to Physical Inactivity in Different Counterfactual Scenarios by Year and Gender in Argentina (Among Individuals Aged 25 to >79 y)

	2005		2009		2013		2018		
Scenario/outcome	ASYLL	95% UI	ASYLL	95% UI	ASYLL	95% UI	ASYLL	95% UI	Average annual change, %
Panel A. TMREL (≥8000 METs min·wk^{-1})									
Colon cancer[a]									
Both	27.70	19.99, 34.53	31.54	23.07, 39.13	32.41	23.66, 40.19	31.16	22.49, 38.70	3.19
Men	27.91	20.14, 34.75	32.33	23.59, 40.16	33.13	24.19, 41.11	31.71	22.81, 39.43	3.51
Women	27.50	19.84, 34.32	30.79	22.57, 38.15	31.73	23.16, 39.32	30.63	22.18, 38.00	2.89
Breast cancer[b]									
Both	NA	NA	NA	NA	NA	NA	NA	NA	
Men	NA	NA	NA	NA	NA	NA	NA	NA	
Women	44.17	34.33, 53.98	47.26	36.24, 57.99	46.85	35.83, 57.68	45.26	34.93, 55.52	0.68
IHD[c]									
Both	76.07	69.42, 82.76	81.70	74.96, 88.57	86.60	79.48, 93.78	82.32	75.29, 89.47	2.11
Men	96.75	88.13, 105.44	98.02	89.67, 106.40	103.35	94.59, 112.03	96.29	87.72, 104.93	−0.02
Women	56.45	51.67, 61.26	66.23	61.01, 71.66	70.72	65.16, 76.47	69.08	63.51, 74.82	5.45
Stroke[d]									
Both	44.75	39.79, 49.74	42.17	37.69, 46.81	37.74	33.70, 41.85	34.04	30.31, 37.81	−6.52
Men	43.23	38.40, 48.05	38.53	34.38, 42.80	35.66	31.84, 39.60	32.81	29.10, 36.51	−6.58
Women	46.19	41.12, 51.35	45.63	40.82, 50.62	39.70	35.47, 43.99	35.21	31.45, 39.05	−6.38
Diabetes[e]									
Both	50.28	39.23, 61.20	48.17	37.70, 58.90	48.30	37.86, 59.12	49.07	38.37, 59.69	−0.58
Men	49.69	39.81, 59.68	46.10	37.09, 55.26	48.21	38.86, 57.73	50.66	40.47, 60.71	0.61
Women	50.84	38.67, 62.64	50.13	38.27, 62.34	48.38	36.91, 60.43	47.58	36.39, 58.72	−1.64
Total									
Both[f]	221.46	186.05, 255.94	227.85	192.01, 263.17	229.09	193.10, 264.55	219.84	184.39, 254.18	−0.15
Men	217.58	186.48, 247.92	214.99	184.73, 244.62	220.34	189.47, 250.48	211.47	180.10, 241.59	−0.68
Women	225.14	185.64, 263.55	240.04	198.92, 280.76	237.39	196.53, 277.89	227.76	188.46, 266.11	0.36
Panel B. PA recommendation (≥600 METs min·wk^{-1})									
Colon cancer									
Both	6.70	−1.41, 14.81	8.78	−1.88, 19.27	9.22	−1.98, 20.20	7.75	−1.64, 17.09	5.03
Men	6.90	−1.46, 15.26	8.82	−1.88, 19.38	9.03	−1.93, 19.83	7.62	−1.61, 16.85	3.65
Women	6.50	−1.37, 14.38	8.74	−1.87, 19.15	9.40	−2.02, 20.54	7.86	−1.67, 17.32	6.41
Breast cancer									
Both	NA	NA	NA	NA	NA	NA	NA	NA	
Men	NA	NA	NA	NA	NA	NA	NA	NA	
Women	5.14	−4.31, 15.19	7.16	−5.85, 20.89	7.41	−6.05, 21.59	5.97	−4.85, 17.45	5.84
IHD									
Both	36.19	29.04, 43.48	42.33	34.07, 50.71	45.44	36.61, 54.37	39.48	31.68, 47.38	2.80
Men	46.37	37.37, 55.88	50.26	40.64, 60.39	52.78	42.72, 63.35	45.12	36.38, 54.34	−0.28
Women	26.52	21.13, 31.72	34.81	27.83, 41.52	38.49	30.81, 45.86	34.13	27.23, 40.78	7.63

(continued)

Table 2 *(continued)*

Scenario/outcome	2005 ASYLL	2005 95% UI	2009 ASYLL	2009 95% UI	2013 ASYLL	2013 95% UI	2018 ASYLL	2018 95% UI	Average annual change, %
Stroke									
Both	17.65	11.81, 23.49	18.75	12.62, 24.87	17.22	11.61, 22.81	13.89	9.31, 18.47	−5.32
Men	17.32	11.51, 22.98	16.72	11.15, 22.13	15.52	10.35, 20.55	12.85	8.53, 17.07	−6.96
Women	17.95	12.10, 23.98	20.67	14.01, 27.46	18.83	12.80, 24.96	14.87	10.04, 19.81	−3.69
Diabetes									
Both	16.63	4.28, 29.43	17.92	4.63, 31.62	18.33	4.75, 32.28	16.56	4.26, 29.31	0.10
Men	16.90	4.59, 29.48	17.03	4.67, 29.51	17.74	4.86, 30.73	16.73	4.53, 29.19	−0.19
Women	16.38	3.98, 29.38	18.77	4.59, 33.63	18.89	4.64, 33.75	16.40	3.99, 29.42	0.51
Total									
Both	79.80	41.50, 119.01	91.46	46.43, 137.18	94.02	47.87, 140.75	80.73	41.12, 121.21	0.82
Men	87.50	52.00, 123.60	92.83	54.58, 131.41	95.07	56.01, 134.47	82.31	47.84, 117.45	−1.23
Women	72.49	31.53, 114.66	90.16	38.71, 142.66	93.02	40.17, 146.69	79.23	34.76, 124.77	3.18
Panel C. 15% reduction in insufficient PA[g]									
Colon cancer									
Both	1.00	−0.21, 2.22	1.32	−0.28, 2.89	1.38	−0.30, 3.03	1.16	−0.25, 2.56	5.15
Men	1.04	−0.22, 2.29	1.32	−0.28, 2.90	1.35	−0.29, 2.97	1.14	−0.24, 2.53	3.41
Women	0.97	−0.20, 2.16	1.31	−0.28, 2.87	1.41	−0.30, 3.08	1.18	−0.25, 2.59	6.59
Breast cancer									
Both	NA	NA	NA	NA	NA	NA	NA	NA	
Men	NA	NA	NA	NA	NA	NA	NA	NA	
Women	0.72	−0.96, 2.49	1.05	−0.93, 3.15	1.10	−0.94, 3.24	0.87	−0.80, 2.66	7.42
IHD									
Both	5.53	4.23, 6.85	6.41	5.03, 7.82	6.84	5.45, 8.25	5.99	4.67, 7.33	2.55
Men	7.17	5.36, 9.08	7.69	5.94, 9.52	7.99	6.34, 9.73	6.92	5.30, 8.62	−0.56
Women	3.97	3.16, 4.74	5.20	4.16, 6.20	5.75	4.61, 6.85	5.10	4.07, 6.10	7.56
Stroke									
Both	2.64	1.77, 3.52	2.81	1.89, 3.72	2.58	1.74, 3.41	2.08	1.40, 2.77	−5.28
Men	2.59	1.72, 3.44	2.50	1.67, 3.31	2.32	1.55, 3.08	1.92	1.28, 2.56	−6.98
Women	2.69	1.81, 3.59	3.09	2.10, 4.11	2.82	1.92, 3.73	2.23	1.51, 2.97	−3.70
Diabetes									
Both	2.49	0.64, 4.41	2.69	0.69, 4.73	2.75	0.71, 4.83	2.48	0.64, 4.39	0.11
Men	2.53	0.69, 4.41	2.55	0.70, 4.42	2.66	0.73, 4.60	2.51	0.68, 4.37	−0.13
Women	2.45	0.60, 4.40	2.81	0.69, 5.03	2.83	0.69, 5.05	2.46	0.60, 4.40	0.58
Total									
Both	12.04	5.94, 18.27	13.76	6.85, 20.78	14.11	7.12, 21.19	12.16	6.05, 18.41	0.75
Men	13.34	7.55, 19.22	14.06	8.03, 20.15	14.33	8.33, 20.38	12.49	7.02, 18.08	−1.38
Women	10.80	4.41, 17.37	13.48	5.74, 21.37	13.91	5.98, 21.95	11.84	5.13, 18.72	3.28

Abbreviations: ASYLL, age-standardized years of life lost; IHD, ischemic heart disease; METs, metabolic equivalent tasks; NA, not applicable; NCDs, noncommunicable diseases; PA, physical activity; TMREL, theoretical minimum risk exposure levels; UI, uncertainty interval.

The 10th revision of the International Statistical Classification of Diseases (ICD-10) was used to classify premature deaths: [a]colon cancer (ICD C18); [b]breast cancer (ICD C50); [c]IHD (ICD I20–I25); [d]stroke (ICD G45 and I64); [e]diabetes mellitus (ICD E11, E14). [f]The total age-standardized rate of years of life lost for both genders was calculated as an average of the rates for each gender weighted by the gender-specific population. [g]Insufficient PA was defined as ≥600 METs $min \cdot wk^{-1}$.

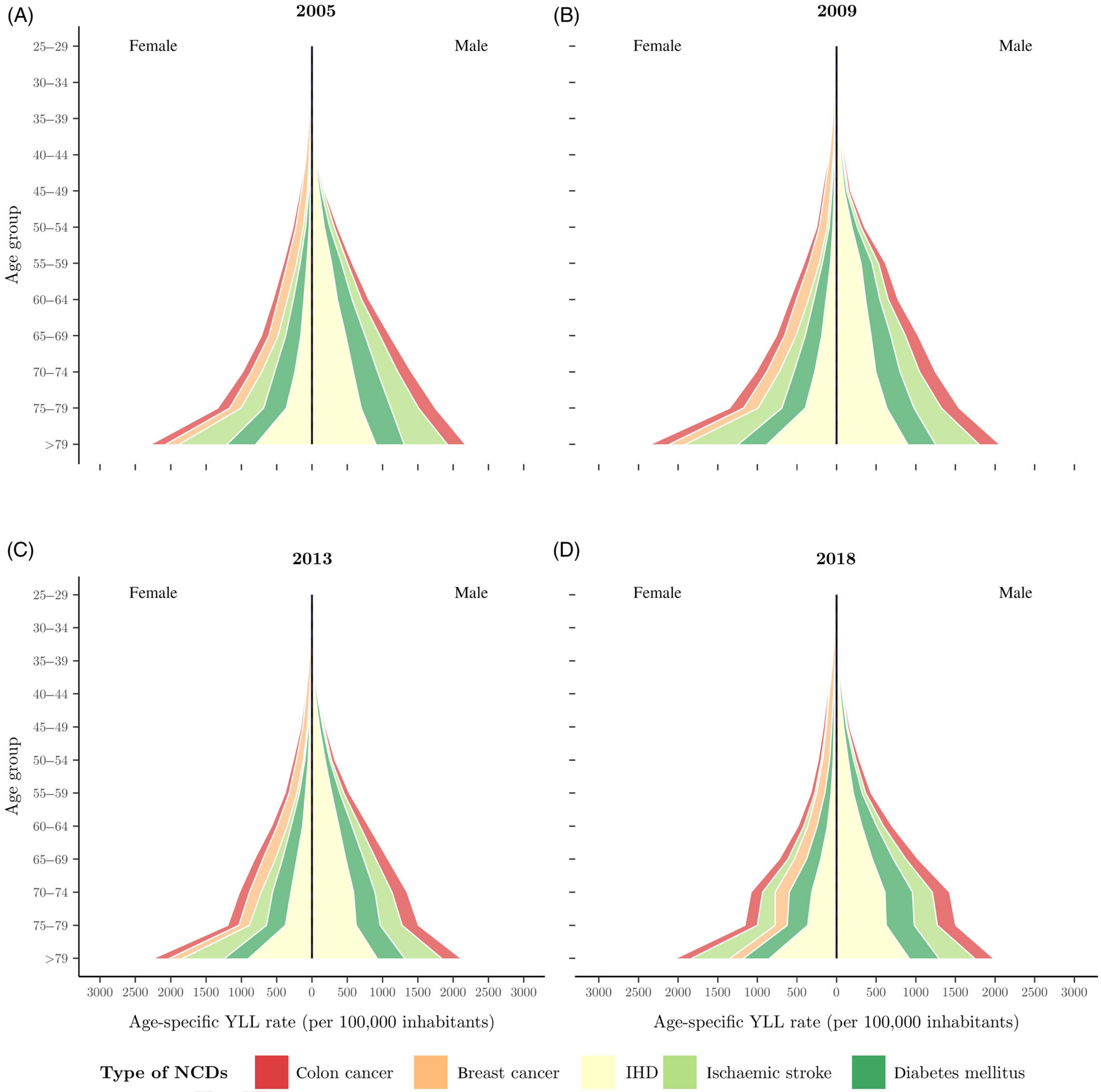


Figure 2 — Age-specific years of life lost rates per 100,000 inhabitants from NCDs attributable to physical inactivity at the TMREL scenario by year, gender, and age group in Argentina (among individuals aged 25 to >79 y of age). Note: Breast cancer was only considered for women (left side of the subfigures). IHD indicates ischemic heart disease; NCDs, noncommunicable diseases; TMREL, theoretical minimum risk exposure levels; YLL, years of life lost.

gender, and province, and for the most part show a sustained trend over time.

Although comparison with other studies is complicated by the variation in the composition of the data and the techniques used, overall, our results align with others reported in the literature. For example, in Brazil, it has been estimated that avoidable deaths due to physical inactivity account for 5.75% of the main NCDs and 3.23% from all causes,[17] with an age-standardized mortality rate for all causes around 12 to 15 deaths per 100,000 population,[38] and gains of 0.34 years in LE.[39] In other studies conducted in China[12] and Canada,[40] gains in LE between 0.68 to 0.91 and 2.5 years were estimated for the total elimination of physical inactivity, the former being in the range of our estimates. A worldwide study estimated that in Argentina the PAFs associated with physical inactivity are

Table 3 Gains in LE From NCDs Attributable to Physical Inactivity at Different Counterfactual Scenarios by Year and Gender in Argentina (Among Individuals Aged 25 to >79 y)

	2005		2009		2013		2018		
Scenario/outcome	**LE gains**	**95% UI**	**LE gains**	**95% UI**	**LE gains**	**95% UI**	**LE gains**	**95% UI**	**Average annual change, %**
Panel A. TMREL (≥8000 METs min·wk^{-1})									
Colon cancer[a]									
Both	0.09	0.06, 0.11	0.11	0.08, 0.13	0.11	0.08, 0.14	0.11	0.08, 0.14	5.56
Men	0.07	0.05, 0.09	0.09	0.07, 0.12	0.09	0.07, 0.11	0.09	0.07, 0.11	7.14
Women	0.11	0.08, 0.14	0.13	0.09, 0.16	0.14	0.10, 0.17	0.13	0.10, 0.17	4.68
Breast cancer[b]									
Both	NA	NA	NA	NA	NA	NA	NA	NA	NA
Men	NA	NA	NA	NA	NA	NA	NA	NA	NA
Women	0.26	0.20, 0.32	0.27	0.21, 0.33	0.28	0.21, 0.34	0.28	0.22, 0.34	1.89
IHD[c]									
Both	0.22	0.20, 0.24	0.24	0.22, 0.26	0.26	0.23, 0.28	0.24	0.22, 0.26	2.43
Men	0.25	0.23, 0.28	0.27	0.25, 0.30	0.29	0.26, 0.31	0.27	0.24, 0.29	2.13
Women	0.14	0.13, 0.15	0.17	0.15, 0.18	0.18	0.16, 0.19	0.18	0.16, 0.20	6.83
Stroke[d]									
Both	0.10	0.09, 0.11	0.09	0.08, 0.10	0.08	0.07, 0.09	0.07	0.06, 0.08	−8.40
Men	0.09	0.08, 0.11	0.08	0.07, 0.09	0.07	0.06, 0.08	0.07	0.06, 0.08	−5.90
Women	0.11	0.10, 0.13	0.10	0.09, 0.12	0.08	0.07, 0.09	0.07	0.06, 0.08	−10.40
Diabetes[e]									
Both	0.14	0.11, 0.17	0.14	0.12, 0.17	0.15	0.12, 0.18	0.16	0.13, 0.19	3.45
Men	0.12	0.09, 0.14	0.12	0.10, 0.14	0.13	0.10, 0.16	0.14	0.11, 0.17	4.01
Women	0.18	0.13, 0.22	0.18	0.14, 0.23	0.17	0.13, 0.22	0.18	0.14, 0.22	0.08
Total									
Both[f]	0.67	0.55, 0.79	0.71	0.59, 0.84	0.72	0.59, 0.85	0.71	0.58, 0.83	1.50
Men	0.54	0.46, 0.61	0.57	0.49, 0.65	0.58	0.50, 0.66	0.57	0.48, 0.65	1.40
Women	0.80	0.64, 0.95	0.85	0.69, 1.02	0.85	0.68, 1.02	0.84	0.67, 1.01	1.27
Panel B. PA recommendation (≥600 METs min·wk^{-1})									
Colon cancer									
Both	0.02	−0.00, 0.04	0.03	−0.01, 0.06	0.03	−0.01, 0.07	0.03	−0.01, 0.06	12.50
Men	0.02	−0.00, 0.04	0.02	−0.01, 0.05	0.02	−0.01, 0.05	0.02	−0.00, 0.05	0.00
Women	0.03	−0.01, 0.06	0.04	−0.01, 0.08	0.04	−0.01, 0.09	0.03	−0.01, 0.07	2.08
Breast cancer									
Both	NA	NA	NA	NA	NA	NA	NA	NA	NA
Men	NA	NA	NA	NA	NA	NA	NA	NA	NA
Women	0.03	−0.02, 0.08	0.04	−0.03, 0.12	0.04	−0.03, 0.12	0.03	−0.03, 0.10	2.08
IHD									
Both	0.10	0.08, 0.12	0.12	0.10, 0.15	0.13	0.11, 0.16	0.11	0.09, 0.13	3.24
Men	0.12	0.09, 0.14	0.14	0.11, 0.17	0.14	0.12, 0.17	0.12	0.10, 0.15	0.59
Women	0.06	0.05, 0.07	0.09	0.07, 0.10	0.09	0.07, 0.11	0.09	0.07, 0.10	12.50

(continued)

Table 3 *(continued)*

	2005		2009		2013		2018		
Scenario/outcome	**LE gains**	**95% UI**	**LE gains**	**95% UI**	**LE gains**	**95% UI**	**LE gains**	**95% UI**	**Average annual change, %**
Stroke									
Both	0.04	0.03, 0.05	0.04	0.03, 0.05	0.03	0.02, 0.05	0.03	0.02, 0.04	–6.25
Men	0.04	0.02, 0.05	0.04	0.02, 0.05	0.03	0.02, 0.04	0.03	0.02, 0.04	–6.25
Women	0.04	0.03, 0.06	0.05	0.03, 0.06	0.04	0.03, 0.05	0.03	0.02, 0.04	–5.00
Diabetes									
Both	0.05	0.01, 0.08	0.05	0.01, 0.09	0.05	0.01, 0.09	0.05	0.01, 0.09	0.00
Men	0.04	0.01, 0.07	0.04	0.01, 0.08	0.05	0.01, 0.08	0.05	0.01, 0.08	6.25
Women	0.06	0.01, 0.10	0.07	0.02, 0.12	0.07	0.02, 0.12	0.06	0.01, 0.11	0.59
Total									
Both	0.21	0.09, 0.33	0.26	0.11, 0.41	0.26	0.11, 0.42	0.23	0.09, 0.37	3.21
Men	0.21	0.13, 0.30	0.24	0.14, 0.34	0.25	0.15, 0.35	0.22	0.12, 0.31	1.61
Women	0.21	0.06, 0.37	0.28	0.08, 0.48	0.28	0.07, 0.49	0.24	0.07, 0.42	4.76
Panel C. 15% reduction in insufficient PA									
Colon cancer									
Both	0.003	–0.000, 0.007	0.004	–0.001, 0.010	0.004	–0.001, 0.010	0.004	–0.001, 0.008	8.33
Men	0.003	–0.000, 0.006	0.004	–0.001, 0.008	0.004	–0.001, 0.008	0.003	–0.001, 0.007	2.08
Women	0.004	–0.001, 0.008	0.005	–0.001, 0.012	0.006	–0.001, 0.013	0.005	–0.001, 0.011	7.08
Breast cancer									
Both	NA	NA	NA	NA	NA	NA	NA	NA	NA
Men	NA	NA	NA	NA	NA	NA	NA	NA	NA
Women	0.004	–0.004, 0.013	0.006	–0.005, 0.017	0.006	–0.005, 0.018	0.005	–0.004, 0.015	8.33
IHD									
Both	0.015	0.012, 0.018	0.019	–0.015, 0.022	0.020	0.016, 0.024	0.017	0.013, 0.020	4.23
Men	0.018	0.014, 0.021	0.021	0.017, 0.025	0.022	0.017, 0.026	0.018	0.015, 0.022	0.81
Women	0.009	0.007, 0.011	0.013	0.010, 0.015	0.014	0.011, 0.017	0.013	0.010, 0.015	11.25
Stroke									
Both	0.006	0.004, 0.008	0.006	0.004, 0.008	0.005	0.003, 0.007	0.004	0.003, 0.005	–9.17
Men	0.005	0.004, 0.007	0.005	0.004, 0.007	0.005	0.003, 0.006	0.004	0.003, 0.005	–5.00
Women	0.006	0.004, 0.008	0.007	0.005, 0.009	0.006	0.004, 0.007	0.004	0.003, 0.005	–7.74
Diabetes									
Both	0.007	0.002, 0.012	0.008	0.002, 0.014	0.008	0.002, 0.014	0.008	0.002, 0.013	3.57
Men	0.006	0.002, 0.010	0.006	0.002, 0.011	0.007	0.002, 0.012	0.007	0.002, 0.012	4.17
Women	0.008	0.002, 0.015	0.010	0.002, 0.018	0.009	0.002, 0.017	0.009	0.002, 0.016	3.75
Total									
Both	0.032	0.014, 0.050	0.039	0.016, 0.062	0.039	0.016, 0.063	0.034	0.014, 0.055	2.26
Men	0.032	0.019, 0.044	0.036	0.021, 0.051	0.037	0.022, 0.052	0.032	0.018, 0.046	0.44
Women	0.032	0.009, 0.056	0.041	0.011, 0.072	0.042	0.011, 0.073	0.036	0.010, 0.063	4.07

Abbreviations: IHD, ischemic heart disease; LE, life expectancy; METs, metabolic equivalent tasks; NA, not applicable; NCDs, noncommunicable diseases; PA, physical activity; TMREL, theoretical minimum risk exposure levels; UI, uncertainty interval.

The 10th revision of the International Statistical Classification of Diseases (ICD-10) was used to classify premature deaths: [a]colon cancer (ICD C18); [b]breast cancer (ICD C50); [c]IHD (ICD I20–I25); [d]stroke (ICD G45 and I64); [e]diabetes mellitus (ICD E11, E14). [f]Total gains in life expectancy for both genders were calculated as an average of the gains in life expectancy for each sex weighted by the gender-specific population. [g]Insufficient PA defined as ≥600 METs $min \cdot wk^{-1}$.

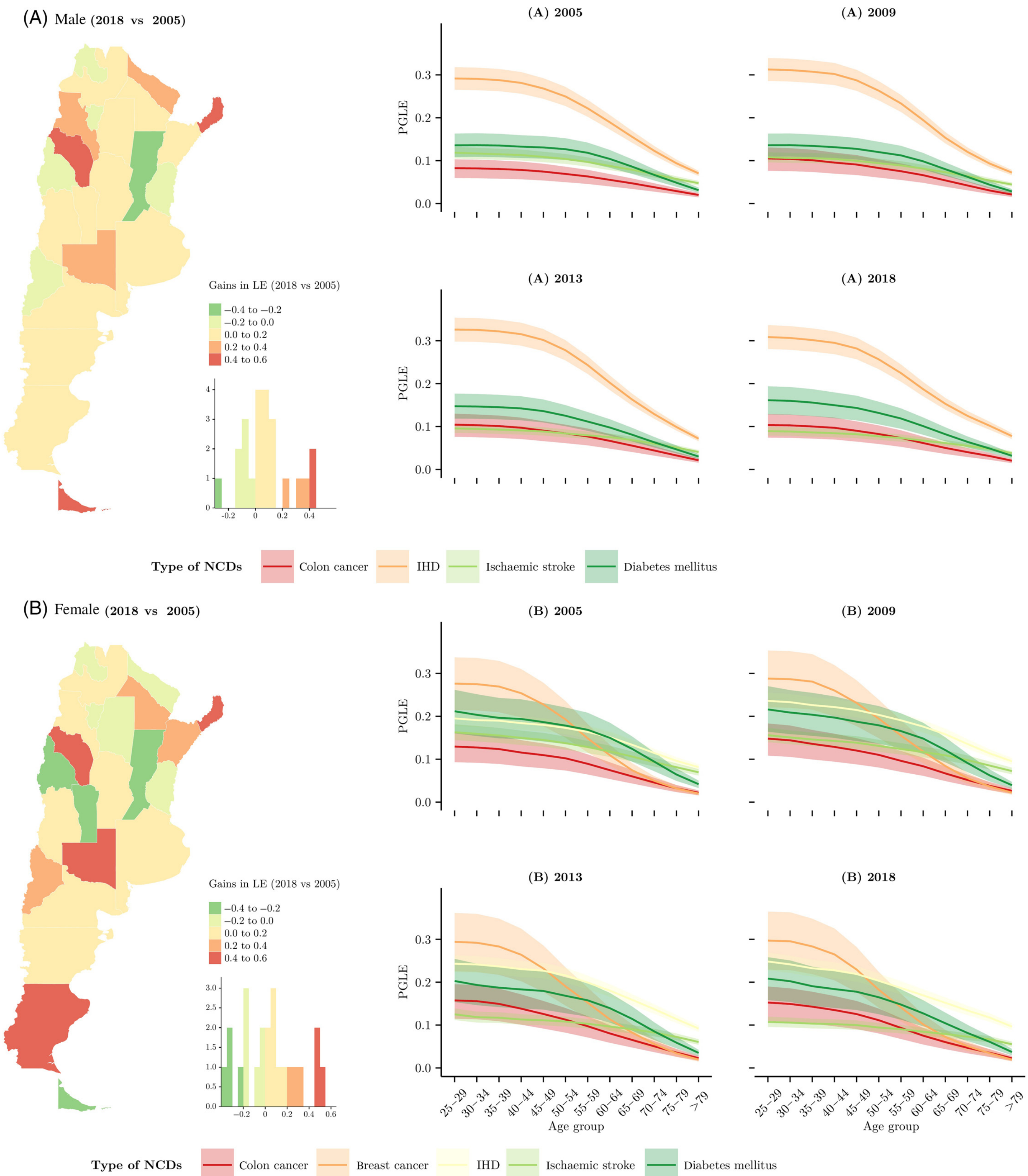


Figure 3 — Spatial and temporal trends in gains in life expectancy from NCDs attributable to physical inactivity in the TMREL scenario by year, gender, and age group in Argentina (from 25 to >79 y of age). Note: Panels A and B present spatial changes in PGLE for all outcomes between 2018 and 2005 (left side); and PGLE trends (2005, 2009, 2013, and 2018) by age group (right side); for both men and women. IHD indicates ischemic heart disease; LE, life expectancy; NCDs, noncommunicable diseases; PGLE, potential gains in life expectancy; TMREL, theoretical minimum risk exposure levels.

11.3 (CHD), 14.0 (type 2 diabetes), 18.5 and 20.2 (breast and colon cancer), and 18.2 (all causes), with 1.31 years of LE gained if physical inactivity was eliminated.[4] Although the PAFs are close to the calculated values (see Supplementary Tables S5–S8 [available online]), overall, they are still below our estimates, while the LE achieved differed significantly. Several paths could explain these discrepancies. Lee et al[41] collected data on both the prevalence of physical inactivity and life tables from WHO for 2008 and found methodological variations concerning the source of physical activity data, exposure definition, and RR estimates in both resources. Lee et al[41] considered RRs arising from all causes in their estimates, whereas we focused on cause-specific RRs in our estimates.[41,42] Other studies in Latin American countries have also verified significant differences from Lee et al[41] with regard to PAF estimates.[17,39]

The estimates reflected by the TMREL scenario lack external validity with respect to the current distribution of the risk factor. Studies on the impact of plausible counterfactual scenarios of physical activity on premature NCD deaths are much more informative for policymakers, but they are still scarce in the literature. Compliance with WHO physical activity recommendations would reduce a significant number of premature deaths from NCDs and consequently increase LE. However, it would be impractical to apply this scenario to the entire population.[43,44] Conversely, achieving a 15% decrease in insufficient physical activity would have a small impact on premature deaths from NCDs. A potentially plausible middle path might be to take age into consideration in creating interventions to promote physical activity; addressing concerns related to spatial heterogeneities could also maximize long-term benefits. Furthermore, a majority of Argentina's population lives in urban areas, so adapting urban environments by developing zones that encourage active transportation, such as green spaces and bicycle lanes, can be cost-effective strategies to motivate the population to practice physical activity.[45] For example, green spaces have been shown to be age-friendly urban environments,[46] providing park space for physical and recreational activities,[47] as well as increasing cardiovascular health by encouraging older adults to become more physically active.[48] Improving the built environment has also been linked with greater physical activity in adults by means of walkable community designs.[49] In addition, although cellphone use has historically been associated with sedentary behaviors,[50] new evidence indicates that, due to increased access to mobile devices, interventions using new communication technologies can be useful tools to promote physical activity either through APPs or strategies combined with calls and SMS.[51]

The YLL and LE gained are especially relevant to gaining insight into trends and the spatial behavior of PDs, given the marked differences in physical inactivity trends across Argentina (see Supplementary Table S4 [available online]). For this reason, nationally representative health survey data were used to construct the distribution of physical activity consistently according to internationally used cutoff points. Furthermore, estimates of RRs were retrieved from a recent meta-analysis of prospective dose–response studies and counterfactual scenarios especially relevant for policymakers were considered. Despite these efforts, our study has several limitations. First, physical activity levels were assessed using questionnaires that are considered subjective and are associated with measurement bias.[52] Information on the MET values associated with the intensity of physical activities was not included, so MET values derived from the IPAQ-SF reliability study were used for each type of activity.[23] Second, the different domains of physical activity were not stratified due to the lack of available data. Third, RR estimates were taken from cohort studies in the United States and European countries, and it is not known whether they can be extrapolated to the Argentine population. Lastly, cause-eliminated life tables method requires a strong assumption to be made. Following Chiang,[53] we calculated the net probability of dying by assuming that the force of decrement function from the i_{th} cause is proportional to the force of decrement function from all causes combined in a given age interval, that is, eliminating a cause of death would not change other mortality forces.

The results indicate that it is crucial to undertake public health initiatives to address the physical inactivity epidemic in order to improve NCD prevention strategies in Argentina. Such initiatives must address the complex and multifactorial causes of physical inactivity, the clear gender and age differences, and the factors underlying these differences, such as contextual factors and differences in individuals' ability to adopt healthier lifestyles. Alternative scenarios that considered plausible increases in the level of physical activity showed a limited to moderate impact, suggesting that high levels of physical activity are required to achieve a substantive impact on NCD prevention. However, much remains to be done in Argentina to promote healthy lifestyles through cost-effective interventions in sensitive areas such as transportation, education, and workplaces.

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