Physical inactivity attributable deaths in Switzerland in 2017

Final report

Maria-Eleni Syleouni, Linda Vinci, Renato Mattli

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Contact
Renato Mattli
Winterthur Institute of Health Economics
Zurich University of Applied Sciences ZHAW
Gertrudstrasse 15, CH-8401 Winterthur
Tel. +41 58 934 78 92 / Email: renato.mattli@zhaw.ch

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Abstract (English)

The present study estimates the population attributable fractions (PAFs) and subsequently the deaths attributable to physical inactivity in Switzerland in 2017. Furthermore, we analyzed the temporal trend of deaths attributable to physical inactivity from 2002 to 2017. Physical inactivity was defined as less than 150 minutes of physical activity with moderate intensity per week or less than 75 minutes of physical activity with high intensity per week. We used the prevalence of physical inactivity from the Swiss Health Survey and risk ratios from the literature to calculate the PAFs per disease, sex and age group. Subsequently the deaths attributable to physical inactivity were calculated by multiplying the PAFs with the number of deaths in the total population as estimated from the Swiss Deaths Statistics. In 2017, 1287 deaths (95%CI 1095-1483) were attributable to physical inactivity. These are 2% of the total deaths occurring in Switzerland in 2017. Cardiovascular diseases contributed 71% to the deaths attributable to physical inactivity and the two cancers, breast and colon, 22%. The age group 75+ contributed most to the number of deaths attributable to physical inactivity and women contributed twice as much deaths as men. Based on the sensitivity analysis, our estimation is likely conservative as we focused on nine diseases (ischemic heart disease, stroke, hypertension, type 2 diabetes, breast cancer, colon cancer, osteoporosis, low back pain, and depression). The temporal trend analysis showed a decrease in the number of deaths attributable to physical inactivity from 2002 to 2012 and a stabilization from 2012 to 2017. Policy makers should aim to further increase physical activity in general and specifically in the age group 75+, especially in women.

Abstract (Deutsch)

Die vorliegende Studie schätzt die population attributable fractions (PAFs) und anschliessend die auf körperliche Inaktivität zurückzuführende Mortalität in der Schweiz im Jahr 2017. Zusätzlich haben wir den zeitlichen Trend der inaktivitätsbedingten Mortalität von 2002 bis 2017 untersucht. Als körperlich inaktiv wurde dabei definiert wer weniger als 150 Minuten körperliche Aktivität bei moderater Intensität pro Woche oder weniger als 75 Minuten körperliche Aktivität mit hoher Intensität ausübt. Wir benutzten die Prävalenz der körperlichen Inaktivität gemäss der Schweizerischen Gesundheitsbefragung und relative Risiken aus der Literatur um die PAFs pro Krankheit, Geschlecht und Altersgruppe zu berechnen. Anschliessend wurden die PAFs mit den Anzahl Todesfällen in der Gesamtbevölkerung gemäss der Todesursachenstatistik multipliziert, um die inaktivitätsbedingten Todesfälle zu schätzen. Im Jahr 2017 gab es 1287 (95%CI 1095-1483) inaktivitätsbedingte Todesfälle. Diese entsprechen 2% aller in der Schweiz im Jahr 2017 aufgetretenen Todesfälle. Die kardiovaskulären Krankheiten trugen 71% zu diesen Todesfällen bei und die beiden Krebsarten, Brustkrebs und Kolonkrebs, 22%. Die Altersgruppe der über 75-Jährigen trug am meisten zu den inaktivitätsbedingten Todesfällen bei und die Frauen doppelt so viel wie die Männer. Basierend auf der durchgeführten Sensitivitätsanalyse muss dabei festgehalten werden, dass unsere Schätzung als konservativ eingestuft werden kann, da wir uns bei der Analyse auf neun Krankheiten eingeschränkt haben (ischämische Herzerkrankungen, Hirnschlag, Bluthochdruck, Diabetes Typ 2, Brustkrebs, Kolonkrebs, Osteoporose, Rückenschmerz und Depression). Der zeitliche Trend zeigte zudem eine Abnahme bei den inaktivitätsbedingten Todesfällen von 2002 bis 2012 und eine Stabilisierung von 2012 bis 2017. Aufgrund der vorliegenden Studie sollten politische Entscheidungsträger darauf abzielen, im Allgemeinen die körperliche Aktivität weiter zu steigern und vor allem in der Altersgruppe der über 75-Jährigen, insbesondere bei Frauen.

Abstract (Français)

Cette étude estime les fractions attribuables dans la population (en anglais, population attributable fractions, PAFs) et, par conséquent, les décès causés par l'inactivité physique en 2017 en Suisse. Nous avons analysé, par la même occasion, la tendance temporelle des décès causés par l'inactivité physique entre 2002 et 2017. L'inactivité physique a été définie comme moins de 150 minutes par semaine d'activité physique à intensité moyenne ou moins de 75 minutes par semaine d'activité physique à haute intensité. Pour calculer les PAFs par maladie, sexe et groupe d'âge nous avons utilisé la prévalence de l'inactivité physique de l'Enquête suisse de la santé et le risque relatif (en anglais, relative risk) des maladies provenant de la littérature. Par la suite, les décès causés par l'inactivité physique ont été calculés en multipliant les PAF par le nombre de décès dans la population totale, tel qu'estimé par la Statistique suisse des causes de décès. En 2017, 1287 décès (95% IC 1095-1483) étaient causés par l'inactivité physique. Ces décès représentent 2% du total des décès survenus en Suisse en 2017. Les maladies cardiovasculaires ont contribué à 71% des décès causés par l'inactivité physique et deux cancers, du sein et du côlon, ont contribué à 22%. La tranche d'âge des 75+ est celle qui contribue le plus au nombre de décès causés par l'inactivité physique et les femmes y contribuent deux fois plus que les hommes. Sur la base de l'analyse de sensibilité, notre estimation est probablement prudente car nous nous sommes concentrés sur neuf maladies seulement (cardiopathie ischémique, accident vasculaire cérébral, hypertension, diabète de type 2, cancer du sein, cancer du côlon, ostéoporose, lombalgie et dépression). L'analyse des tendances temporelles a montré une diminution du nombre de décès causés par l'inactivité physique de 2002 à 2012 et une stabilisation entre 2012 et 2017. Les décideurs politiques devraient se préfixer une ultérieure augmentation de l'activité physique en général et plus particulièrement dans la tranche d'âge des 75+, notamment chez les femmes.

Abstract (Italiano)

Il presente studio stima le frazioni attribuibili nella popolazione (in inglese, population attributable fractions, PAFs) e successivamente i decessi causati dall'inattività fisica nel 2017 in Svizzera. Inoltre, è stato analizzato l'andamento temporale dei decessi provocati dall'inattività fisica dal 2002 al 2017. L'inattività fisica è stata definita come meno di 150 minuti di attività fisica di intensità media alla settimana oppure meno di 75 minuti di attività fisica di intensità elevata alla settimana. Per calcolare i PAF per malattia, sesso e fascia d'età abbiamo utilizzato la prevalenza dell'inattività fisica dell'Indagine nazionale sulla salute in Svizzera e il rischio relativo (in inglese, risk ratios) dei casi di malattia dalle pubblicazioni. Successivamente, i casi di decesso causati dall'inattività fisica sono stati calcolati moltiplicando i PAF con il numero di decessi nella popolazione totale. Tali dati di mortalità provengono dalla Statistica delle cause di morte in Svizzera. Nel 2017, l'inattività fisica ha provocato 1287 decessi (95%CI 1095-1483), cioè 2% del totale dei decessi avvenuti nel 2017 in Svizzera. Il 71% dei decessi causati dall' inattività fisica sono riconducibili a malattie cardiovascolari e il 22% a due tumori, seno e colon. La fascia d'età 75+ ha contribuito maggiormente al numero di decessi provocati dall'inattività fisica e le donne hanno contribuito ai decessi in doppia misura rispetto agli uomini. Sulla base dell'analisi di sensibilità, la nostra stima è probabilmente prudente, poiché ci siamo concentrati solamente su nove malattie (cardiopatia ischemica, ictus, ipertensione, diabete di tipo 2, cancro al seno, cancro al colon, osteoporosi, mal di schiena e depressione). L'analisi dell'andamento temporale ha mostrato una diminuzione del numero di decessi causati dall'inattività fisica dal 2002 al 2012 e una stabilizzazione dal 2012 al 2017. I responsabili politici dovrebbero puntare ad aumentare ulteriormente l'attività fisica in generale e in particolare nella fascia d'età 75+, soprattutto nelle donne.

1. Background and aim of the study

Physical inactivity is a major risk factor for numerous non-communicable diseases [1-3]. The global health burden of physical inactivity is substantial [4]. In 2015, 1.6 million deaths and 34.6 million disability-adjusted life-years (DALYs) were attributable to physical inactivity [5]. Besides the health burden, physical inactivity also causes an associated economic burden worldwide [6-8]. A substantial health and economic burden due to physical inactivity has also been shown for Switzerland [9-11]. However, the most recent Swiss study focused on DALYs and the economic burden of physical inactivity but did not include deaths [11]. Therefore, the Federal Office of Public Health approached the Winterthur Institute of Health Economics to update the number of deaths attributable to physical inactivity according to the latest data available [10].

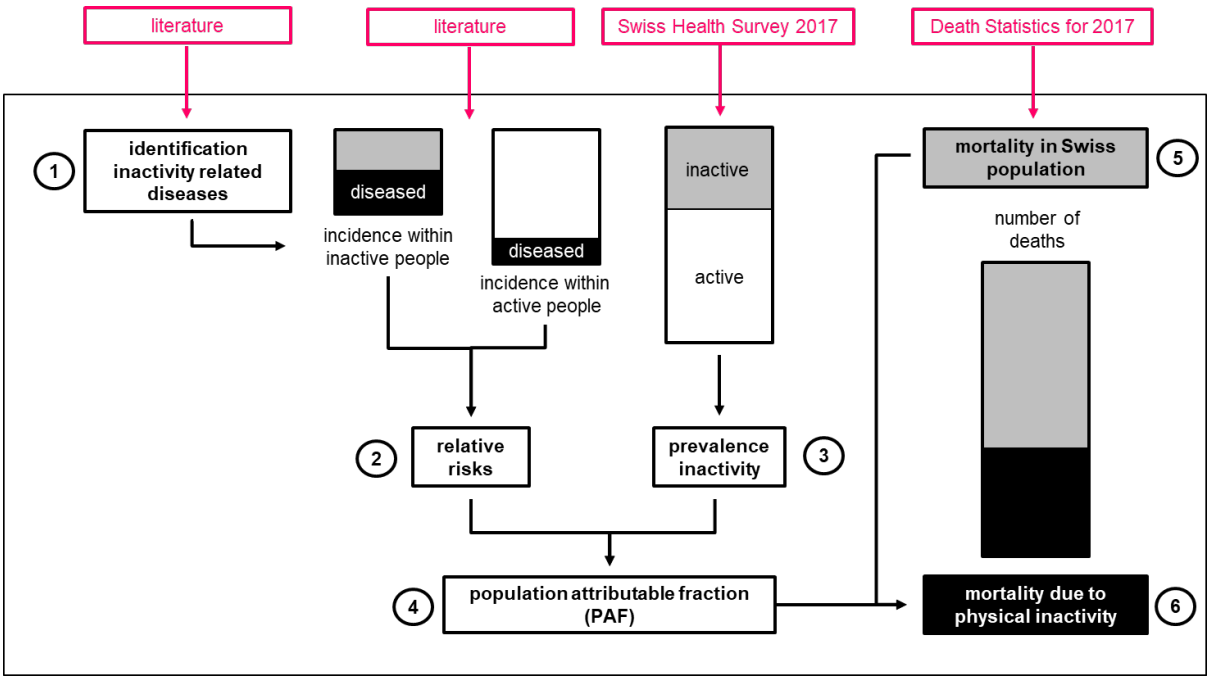
2. Materials and methods

In this section we describe the data sources used and methods applied to estimate the population attributable fractions and subsequently the deaths attributable to physical inactivity.

2.1 Overview

The methodological approach was based on previous studies estimating the burden of physical inactivity in Switzerland [10, 11]. Figure 1 presents an overview of the data sources as well as the methods used in this study to estimate the number of deaths attributable to physical inactivity. In a first step, diseases related to physical inactivity were identified in the literature. For the identified diseases, we then searched the relative risk. These relative risks were in a next step combined with the prevalence of physical inactivity to estimate the population attributable fractions (PAFs). The PAFs were then multiplied with the number of deaths in the total population in order to estimate the number of deaths attributable to physical inactivity.

Figure 1: Overview of data sources and methods



Source: Adapted from Mattli et al. 2019 [11]. (1) In a first step, diseases related to physical inactivity were identified in the literature. (2) For the identified diseases, we then searched for the relative risks in the international literature. (3) The prevalence of physical inactivity was estimated based on the latest Swiss Health Survey from 2017. (4) The prevalence of physical inactivity was combined with the relative risks to estimate the population attributable fractions (PAFs). (5) The mortality in the Swiss population was estimated based on the Death Statistics for 2017. (6) The number of deaths in the total population was then multiplied with the PAFs in order to estimate the number of deaths attributable to physical inactivity.

2.2 Definition of physical inactivity

Due to the health-enhancing effects of physical activity, the world health organization (WHO) recommends for adults at least 2.5 hours of physical activity with moderate intensity or 1.25 hours with high intensity per week [12]. These WHO guidelines have been adopted by the Swiss Federal Office of Sport [13]. Consequently, people not complying with these guidelines are considered as physically inactive in our study.

2.3 Diseases included in the analysis and relative risks

Epidemiological studies consistently show substantial association between physical inactivity and the occurrence of the following diseases [1-3]: ischemic heart disease (IHD), stroke, hypertension, type 2 diabetes, breast cancer, colon cancer, osteoporosis, low back pain, and depression. We focused on these nine diseases for which relative risks (RRs) were available from systematic reviews and meta-analyses, although many more diseases have been associated with physical inactivity [14]. In addition, these nine diseases were included in previous studies investigating the burden of physical inactivity in Switzerland [10, 11]. We used the adjusted RRs from previous studies investigating the health and economic burden of physical inactivity (Table 1) [4, 11].

Table 1: Adjusted relative risks (RR) extracted from the literature

Disease	Adjusted RR	95% CI lower bound	95% CI upper bound	References
Ischemic Heart Disease	1.16	1.04	1.30	[15]
Type 2 diabetes	1.20	1.10	1.33	[16]
Breast cancer*	1.33	1.26	1.42	[4]
Colon cancer	1.32	1.23	1.39	[17]
Hypertension	1.36	1.28	1.45	[18]
Stroke	1.18	1.08	1.28	[19]
Low back pain	1.16	1.06	1.27	[3]
Depression	1.20	1.11	1.32	[2]
Osteoporosis	1.57	1.38	1.77	[18]

*Legend: * RR for breast cancer applies only to women*

2.4 Prevalence of physical inactivity

The prevalence estimates used for this study were publicly available data of the Swiss Health Survey (SHS) provided by the Federal Statistical Office (FSO) [20]. The SHS is conducted every five years and we considered the data from 2017 reported by age group (35-44, 45-54, 55-64, 65-74, 75+ years old) and sex. People younger than 35 years old were not considered in our study as this age group causes a very low number of deaths related to the diseases included. Participants were categorized in four physical activity levels:

- Inactive: Less than 30 minutes of moderate physical activity or engaging in intense physical activity less than once per week
- Partially active: 30–149 minutes of moderate physical activity or engaging in intense physical activity once per week
- Sufficiently active: At least 150 minutes of moderate physical activity or engaging in intense physical activity twice per week
- Trained: Engaging in intense physical activity at least three times per week

For our analysis, we considered the categories trained and sufficiently active as the physically active group and the partially active and inactive as the physically inactive group. This dichotomization was based on the WHO guidelines described in section 2.2. Given the new groups, new point estimates and their Wald confidence intervals were estimated for the physically active and the physically inactive group.

2.5 Calculation of population attributable fractions

We used the following formula to estimate the PAF for each age-sex-group [21]:

$$PAF = \frac{P(RR - 1)}{P(RR - 1) + 1}$$

Where P is the prevalence of physical inactivity in an age-sex-group and RR the adjusted relative risk.

2.6 Number of deaths in total population and attributable to physical inactivity

The number of deaths for each disease included in this study was estimated using the Swiss Death Statistics (SDS) for 2017 provided by the FSO. The death count for each disease were obtained for men and women separately and for each age group (35-44, 45-54, 55-64, 65-74, 75+ years old). To identify each disease of interest we used the ICD-10 codes presented in Table 2.

The number of deaths in each age-sex-group were then multiplied with the corresponding PAF to estimate the number of deaths attributable to physical inactivity.

Table 2: ICD-10 codes used for identification of the included diseases in the Swiss Death Statistics

Disease	ICD-10-GM Codes
Ischemic heart disease	I20-I25
Stroke	I60-I67, I69.0, I69.1, I69.2, I69.3
Hypertension	I10-I15
Type 2 diabetes	E11-E14 (E11.2*, E12.2*, E13.2*)
Breast cancer	C50
Colon cancer	C18-C20
Osteoporosis	M80-M85
Low back pain	M46.9, M47, M48.0-M48.2, M48.8-M48.9, M51-M54 (M53*)
Depression	F32-F33, F34.1

*Legend: * ICD-10 codes excluded from the disease identification*

2.7 Analysis over time

To analyze the temporal trend, we also calculated the PAFs and subsequently the deaths attributable to physical inactivity for the previous years in which physical activity was investigated in the SHS (2002, 2007, 2012). For this additional analysis, we used the same methods and data sources as described above. Consequently, we considered the same diseases, assumed constant RRs over time and used the SHS and SDS to estimate the prevalence of physical inactivity and the number of deaths in the total population, respectively. In addition to the number of deaths, we estimated age- and sex-standardized death rates based on the Swiss population data provided by the FSO.

2.8 Sensitivity analysis

2.8.1 Probabilistic sensitivity analysis

A probabilistic sensitivity analysis (PSA) was conducted to estimate 95% credible intervals (CI) for the PAFs. PSA is a method used to account for the parameter uncertainty in a model [22]. In this study, we performed a PSA to consider the uncertainty in the prevalence and RR estimates from the published data. We used the following distributions for this analysis: lognormal distribution for the RR and beta distribution for the prevalence of physical inactivity. 1000 Monte Carlo simulations were run. The entire model including the sensitivity analyses was implemented in Excel 2010 (Microsoft, Redmond, Washington, USA).

2.8.2 Plausibility check with all-cause mortality

In addition to the PSA, we also conducted a plausibility check for the number of deaths attributable to physical inactivity using the relative risk for all-cause mortality from the study by Lee et al. (RR 1.28 (95%CI1.21-1.36)) [4]. We calculated the population attributable fractions

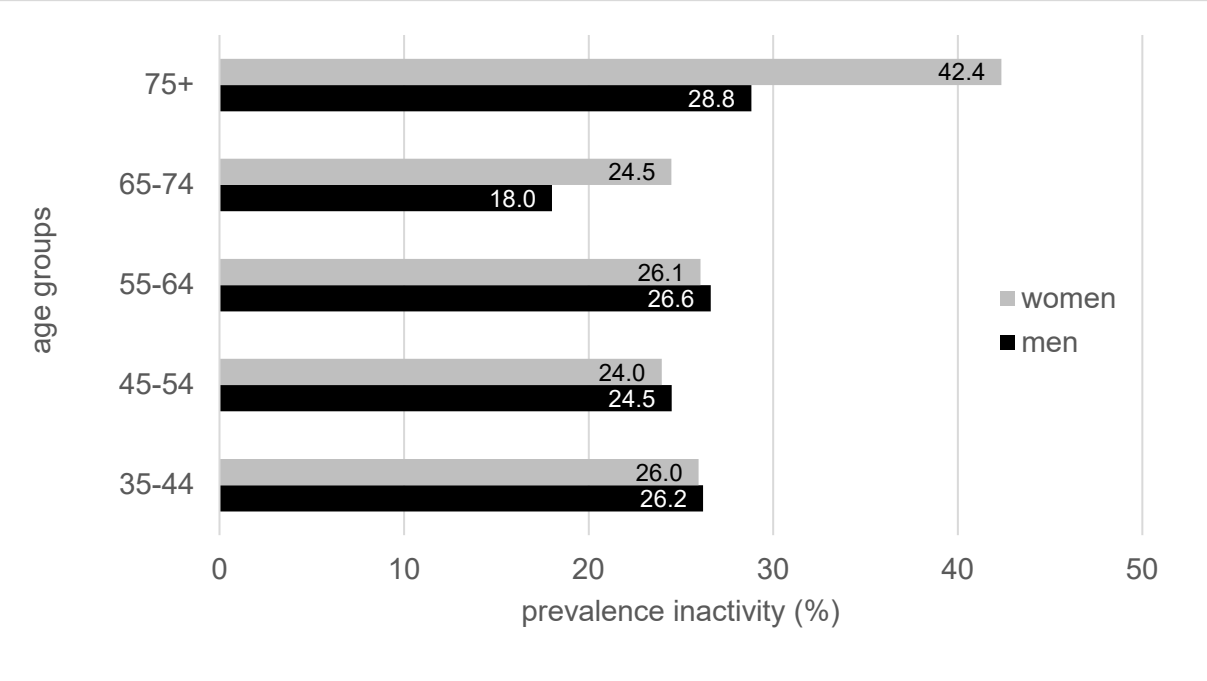
and subsequently the deaths attributable to physical inactivity using the same methods and data sources as described above.

3. Results

3.1 Prevalence of physical inactivity

From the age of 35 years to 65 years, the prevalence of physical inactivity is approximately 25% in women and men (Figure 2). After the retirement (currently 64 years for women and 65 years for men), men get less inactive (namely more active) whereas women remain on the level before retirement. In the oldest age group (75+) prevalence of inactivity is highest with 28.8% in men and 42.4% in women.

Figure 2: Prevalence of physical inactivity for women and men based on the Swiss Health Survey 2017



3.2 Population attributable fractions

The PAFs for physical inactivity by age group are shown in Table 3 for men and in Table 4 for women. In all age groups and both sexes the highest PAFs were identified for osteoporosis and the lowest for IHD and low back pain. As the same RRs were used across age and sex groups, the difference in the PAFs between age and sex groups are driven by the difference in the prevalence of physical inactivity (see Figure 2 above). Consequently, PAFs do not substantially differ between the age groups 35-44, 45-54 and 55-64. In these three age groups, PAFs are also not substantially different between women and men. For the two age groups 65-74 and 75+ higher PAFs were observed in women than in men. For women and men, highest PAFs were observed in the age group 75+. The lowest PAFs were identified for women in the age group 45-54 and in men in the age group 65-74.

Table 3: Men, population attributable fractions due to physical inactivity and 95% CI in Switzerland in 2017 per disease and age group

Men	35-44			45-54			55-64			65-74			75+		
Disease	**PAF**	**95% CI lb**	**95% CI ub**	**PAF**	**95% CI lb**	**95% CI ub**	**PAF**	**95% CI lb**	**95% CI ub**	**PAF**	**95% CI lb**	**95% CI ub**	**PAF**	**95% CI lb**	**95% CI ub**
IHD	0.040	0.009	0.071	0.038	0.008	0.067	0.041	0.008	0.073	0.028	0.006	0.051	0.044	0.010	0.077
Stroke	0.045	0.022	0.070	0.042	0.022	0.065	0.046	0.023	0.070	0.031	0.016	0.048	0.049	0.025	0.078
Hypertension	0.086	0.065	0.105	0.081	0.062	0.100	0.087	0.066	0.107	0.061	0.045	0.077	0.094	0.073	0.118
Type 2 diabetes	0.050	0.019	0.081	0.047	0.019	0.075	0.051	0.020	0.082	0.035	0.014	0.058	0.054	0.022	0.091
Breast cancer	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Colon cancer	0.077	0.061	0.095	0.073	0.058	0.089	0.078	0.062	0.097	0.055	0.041	0.068	0.084	0.066	0.104
Osteoporosis	0.130	0.092	0.169	0.123	0.086	0.161	0.132	0.092	0.175	0.093	0.064	0.124	0.141	0.100	0.185
Low back pain	0.040	0.015	0.069	0.038	0.015	0.064	0.041	0.015	0.069	0.028	0.011	0.047	0.044	0.017	0.076
Depression	0.050	0.023	0.078	0.047	0.022	0.073	0.051	0.023	0.079	0.035	0.016	0.056	0.054	0.026	0.086

Legend: IHD=Ischemic heart disease. The upper and lower bound for the 95% CI of the PAF were acquired from the probabilistic sensitivity analysis

Table 4: Women, population attributable fractions due to physical inactivity and 95% CI in Switzerland in 2017 per disease and age group

Women	35-44			45-54			55-64			65-74			75+		
Disease	**PAF**	**95% CI lb**	**95% CI ub**	**PAF**	**95% CI lb**	**95% CI ub**	**PAF**	**95% CI lb**	**95% CI ub**	**PAF**	**95% CI lb**	**95% CI ub**	**PAF**	**95% CI lb**	**95% CI ub**
IHD	0.040	0.010	0.072	0.037	0.009	0.067	0.040	0.010	0.072	0.038	0.010	0.069	0.063	0.018	0.112
Stroke	0.045	0.021	0.068	0.041	0.020	0.064	0.045	0.021	0.068	0.042	0.020	0.064	0.071	0.032	0.108
Hypertension	0.085	0.065	0.107	0.079	0.061	0.099	0.086	0.066	0.106	0.081	0.062	0.102	0.132	0.102	0.162
Type 2 diabetes	0.049	0.020	0.077	0.046	0.019	0.071	0.050	0.021	0.078	0.047	0.020	0.075	0.078	0.033	0.122
Breast cancer	0.079	0.059	0.100	0.073	0.055	0.093	0.079	0.060	0.102	0.075	0.056	0.095	0.123	0.094	0.154
Colon cancer	0.077	0.060	0.095	0.071	0.056	0.087	0.077	0.060	0.094	0.073	0.057	0.090	0.119	0.094	0.143
Osteoporosis	0.129	0.091	0.169	0.120	0.084	0.157	0.129	0.092	0.167	0.122	0.085	0.161	0.195	0.141	0.246
Low back pain	0.040	0.017	0.066	0.037	0.015	0.063	0.040	0.017	0.068	0.038	0.015	0.066	0.063	0.028	0.107
Depression	0.049	0.022	0.078	0.046	0.020	0.072	0.050	0.022	0.077	0.047	0.021	0.075	0.078	0.036	0.120

Legend: IHD=Ischemic heart disease. The upper and lower bound for the 95% CI of the PAF were acquired from the probabilistic sensitivity analysis

3.3 Number of deaths in total population

In 2017, 17783 deaths occurred due to the diseases related to physical inactivity and in the age groups investigated in this study (Table 5). For men and women, the highest number of deaths was found for IHD, followed by hypertension and stroke. The diseases with the lowest number of deaths for both men and women were low back pain, osteoporosis and depression. Men showed a higher number of deaths than women for IHD, type 2 diabetes and colon cancer. For both men and women, the number of deaths increased with increasing age.

Table 5: Number of deaths in total population by sex and age group for Switzerland in 2017

	Men					Women					Total
Disease	**35-44**	**45-54**	**55-64**	**65-74**	**75+**	**35-44**	**45-54**	**55-64**	**65-74**	**75+**	
IHD	35	135	330	657	2743	3	25	62	216	2896	7102
Stroke	12	32	65	187	983	8	15	44	124	1619	3089
Hypertension	1	16	44	99	874	2	4	18	84	2013	3155
Type 2 diabetes	2	13	49	79	413	0	4	15	35	460	1070
Breast cancer	0	0	0	3	9	30	142	191	310	674	1359
Colon cancer	8	50	121	243	508	12	37	86	175	477	1717
Osteoporosis	0	0	0	4	14	0	0	0	3	89	110
Low back pain	0	0	1	2	9	0	0	0	8	23	43
Depression	1	7	3	8	24	0	3	4	13	75	138
Total	59	253	613	1282	5577	55	230	420	968	8326	17783

Legend: IHD=Ischemic heart disease

3.4 Number of deaths attributable to physical inactivity

In 2017, 1287 deaths (95%CI 1095-1483) were attributable to physical inactivity (Table 6). These are 7.2% of the deaths caused by the diseases included in the study and 2.0% of the 65912 total deaths occurring in Switzerland in 2017. The three cardiovascular diseases, i.e. IHD, stroke and hypertension, contributed 71% to the deaths attributable to physical inactivity and the two cancers, i.e. breast and colon cancer, 22% (Figure 3). The remaining diseases contributed much fewer cases of deaths.

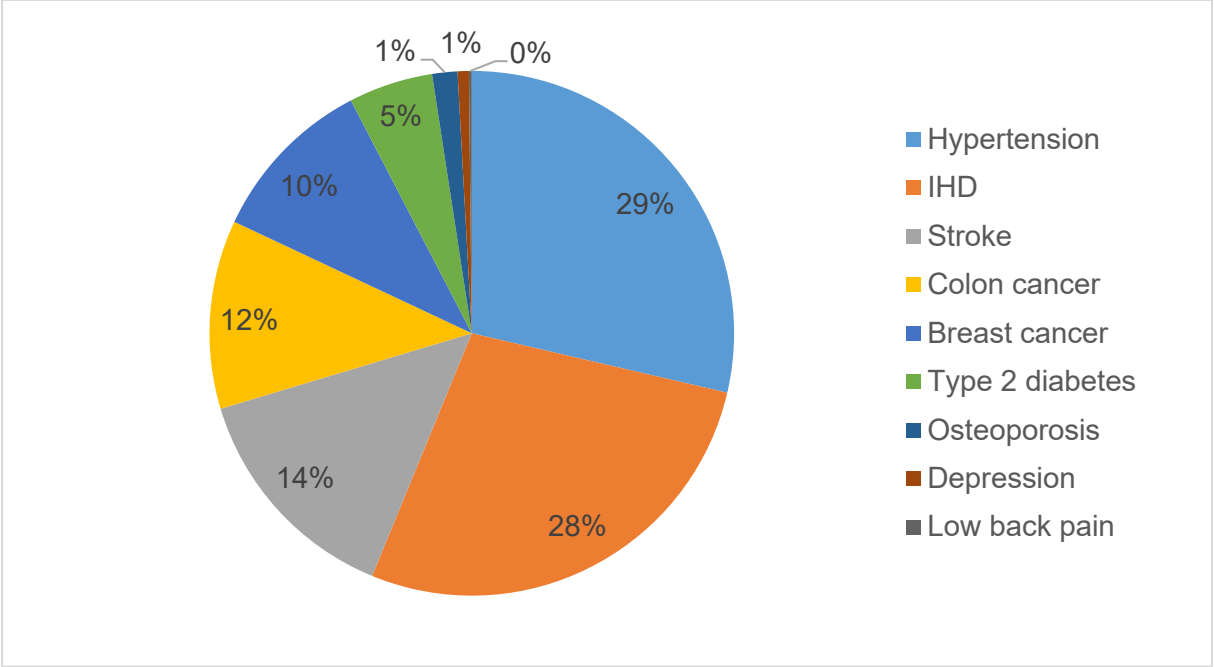
Women caused substantially more deaths attributable to physical inactivity (872, 68% of total number of deaths attributable to physical inactivity) than men (415, 32% of total number of deaths attributable to physical inactivity) (Figure 4). The number of deaths attributable to physical inactivity by age group are presented in Table 7 for men, in Table 8 for women and in Table 9 as well as in Figure 5 for both sexes. Number of deaths attributable to physical inactivity increased with increasing age in both sexes.

Table 6: Number of deaths attributable to physical inactivity in Switzerland in 2017

	Men		Women		Both sexes	
Disease	**Total deaths**	**Inactivity attributable deaths (% of total)**	**Total deaths**	**Inactivity attributable deaths (% of total)**	**Total deaths**	**Inactivity attributable deaths (% of total)**
IHD	3900	159 (4.1%)	3202	196 (6.1%)	7102	355 (5.0%)
Stroke	1279	59 (4.6%)	1810	123 (6.8%)	3089	182 (5.9%)
Hypertension	1034	93 (9.0%)	2121	275 (13.0%)	3155	369 (11.7%)
Type 2 diabetes	556	28 (5.1%)	514	38 (7.5%)	1070	67 (6.3%)
Breast cancer	12	0 (0.0%)	1347	134 (9.9%)	1359	134 (9.8%)
Colon cancer	930	70 (7.5%)	787	80 (10.1%)	1717	150 (8.7%)
Osteoporosis	18	2 (13.0%)	92	18 (19.2%)	110	20 (18.2%)
Low back pain	12	0 (4.1%)	31	2 (5.7%)	43	2 (5.2%)
Depression	43	2 (4.9%)	95	7 (7.2%)	138	9 (6.5%)
Total	7784	415 (5.3%)	9999	872 (8.7%)	17783	1287 (7.2%)

Legend: IHD=Ischemic heart disease. Number of deaths for population older than 35 years

Figure 3: Contribution of the diseases to the deaths attributable to physical inactivity in Switzerland in 2017



Legend: IHD=Ischemic heart disease. Overview of all nine diseases included in the present study.

Figure 4: Contribution of the sexes to the deaths attributable to physical inactivity in Switzerland in 2017

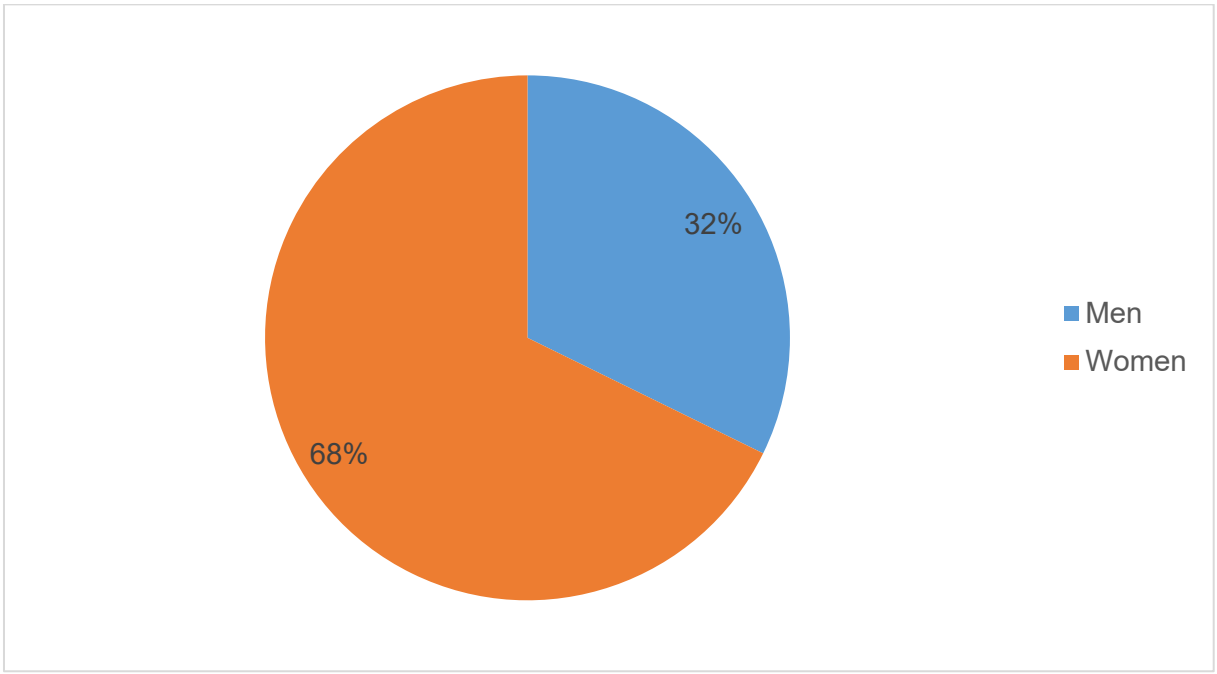


Figure 5: Contribution of the age groups to the deaths attributable to physical inactivity in Switzerland in 2017

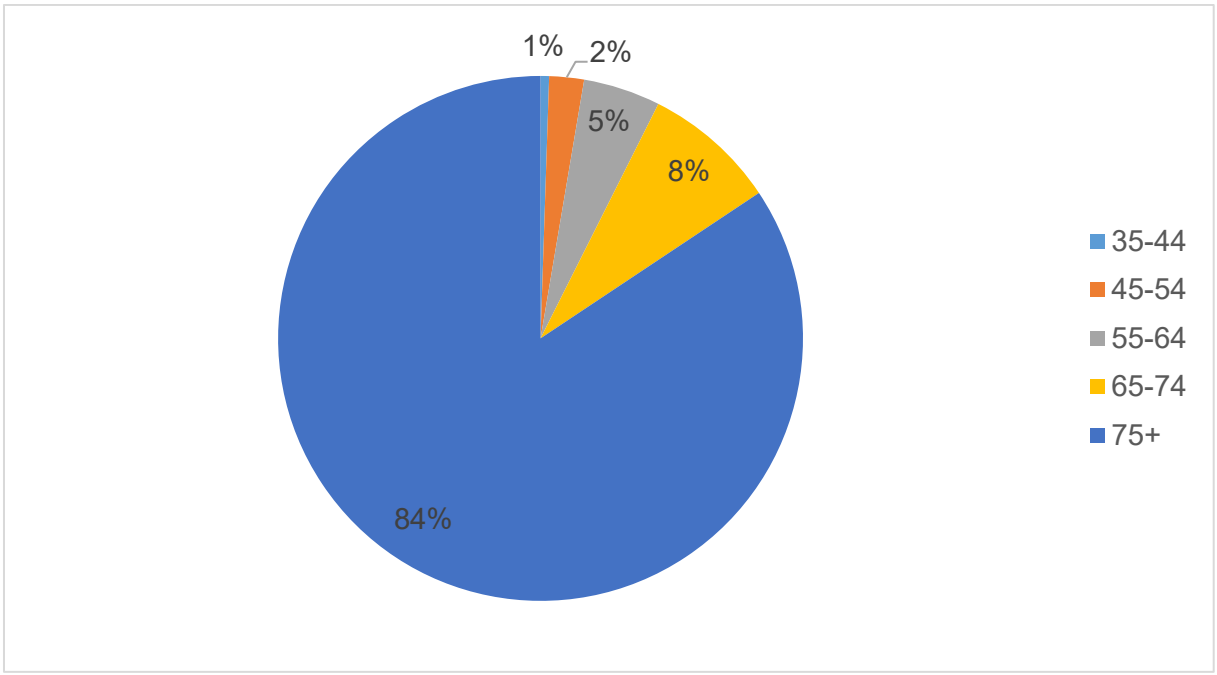


Table 7: Men, number of deaths attributable to physical inactivity and 95% CI in Switzerland in 2017 per disease and age group (rounded numbers)

Men	**35-44**			**45-54**			**55-64**			**65-74**			**75+**			**Total**		
Disease	**deaths**	**95% CI lb**	**95% CI ub**	**deaths**	**95% CI lb**	**95% CI ub**	**deaths**	**95% CI lb**	**95% CI ub**	**deaths**	**95% CI lb**	**95% CI ub**	**deaths**	**95% CI lb**	**95% CI ub**	**deaths**	**95% CI lb**	**95% CI ub**
IHD	1	0	2	5	1	9	13	3	24	18	4	34	121	26	211	159	63	252
Stroke	1	0	1	1	1	2	3	1	5	6	3	9	48	25	77	59	35	88
Hypertension	0	0	0	1	1	2	4	3	5	6	4	8	82	64	104	93	75	115
Type 2 diabetes	0	0	0	1	0	1	2	1	4	3	1	5	23	9	37	28	15	44
Breast cancer	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Colon cancer	1	0	1	4	3	4	9	7	12	13	10	17	43	34	53	70	60	81
Osteoporosis	0	0	0	0	0	0	0	0	0	0	0	0	2	1	3	2	2	3
Low back pain	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1
Depression	0	0	0	0	0	1	0	0	0	0	0	0	1	1	2	2	1	3
Total	3	2	4	12	8	16	32	21	44	47	32	63	321	220	419	415	313	516

Legend: IHD=Ischemic heart disease. Differences in total due to rounding

Table 8: Women, number of deaths attributable to physical inactivity and 95% CI in Switzerland in 2017 per disease and age group (rounded numbers)

Women	**35-44**			**45-54**			**55-64**			**65-74**			**75+**			**Total**		
Disease	**deaths**	**95% CI lb**	**95% CI ub**	**deaths**	**95% CI lb**	**95% CI ub**	**deaths**	**95% CI lb**	**95% CI ub**	**deaths**	**95% CI lb**	**95% CI ub**	**deaths**	**95% CI lb**	**95% CI ub**	**deaths**	**95% CI lb**	**95% CI ub**
IHD	0	0	0	1	0	2	2	1	4	8	2	15	184	51	324	196	62	336
Stroke	0	0	1	1	0	1	2	1	3	5	2	8	115	53	175	123	61	183
Hypertension	0	0	0	0	0	0	2	1	2	7	5	9	266	204	327	275	213	336
Type 2 diabetes	0	0	0	0	0	0	1	0	1	2	1	3	36	15	56	38	18	59
Breast cancer	2	2	3	10	8	13	15	11	20	23	17	29	83	63	104	134	113	156
Colon cancer	1	1	1	3	2	3	7	5	8	13	10	16	57	45	68	80	67	92
Osteoporosis	0	0	0	0	0	0	0	0	0	0	0	0	17	13	22	18	13	22
Low back pain	0	0	0	0	0	0	0	0	0	0	0	1	1	1	2	2	1	3
Depression	0	0	0	0	0	0	0	0	0	1	0	1	6	3	9	7	4	10
Total	4	3	5	15	12	18	29	24	34	59	50	69	765	603	933	872	709	1040

Legend: IHD=Ischemic heart disease. Differences in total due to rounding

Table 9: Both sexes, number of deaths attributable to physical inactivity and 95% CI in Switzerland in 2017 per disease and age group (rounded numbers)

	35-44			45-54			55-64			65-74			75+			Total		
Disease	**deaths**	**95% CI lb**	**95% CI ub**	**deaths**	**95% CI lb**	**95% CI ub**	**deaths**	**95% CI lb**	**95% CI ub**	**deaths**	**95% CI lb**	**95% CI ub**	**deaths**	**95% CI lb**	**95% CI ub**	**deaths**	**95% CI lb**	**95% CI ub**
IHD	2	0	3	6	2	10	16	5	27	27	11	43	305	142	472	355	190	523
Stroke	1	1	1	2	1	3	5	3	7	11	7	15	163	97	230	182	115	249
Hypertension	0	0	0	2	1	2	5	4	6	13	11	15	349	284	413	369	304	433
Type 2 diabetes	0	0	0	1	0	1	3	2	5	4	2	6	58	34	84	67	42	92
Breast cancer	2	2	3	10	8	13	15	11	20	23	17	29	83	63	104	134	113	156
Colon cancer	2	1	2	6	5	7	16	14	19	26	22	30	100	85	115	150	134	166
Osteoporosis	0	0	0	0	0	0	0	0	0	1	1	1	19	14	24	20	15	25
Low back pain	0	0	0	0	0	0	0	0	0	0	0	1	2	1	3	2	1	3
Depression	0	0	0	0	0	1	0	0	0	1	1	1	7	4	10	9	6	12
Total	7	5	8	28	23	33	61	49	73	106	88	125	1086	895	1280	1287	1095	1483

Legend: IHD=Ischemic heart disease. Differences in total due to rounding

3.5 Analysis over time

The number of deaths attributable to physical inactivity decreased from 1678 in 2002 to 1287 in 2017 (Table 10). The decrease mainly happened between 2002 and 2012 and the numbers remained stable from 2012 to 2017. This temporal trend was also observed separately in men (Table 11) and women (Table 12). However, when looking at the age- and sex-standardized death rates, we see a decrease from 2002 to 2017 in women and men in all age groups, except men 45 to 54 years old and 65 to 74 years old showed a slight increase from 2012 to 2017 (see Tables S1 and S2). As shown in Figure S1 and S2, the prevalence of physical inactivity decreased in all age groups between 2002 and 2017. The total deaths caused by the included diseases (ischemic heart disease, stroke, hypertension, type 2 diabetes, breast cancer, colon cancer, osteoporosis, low back pain and depression) slightly decreased between 2002 and 2012 and then increased from 2012 to 2017 (Figure S3).

The contribution of IHD to the deaths attributable to physical inactivity decreased over time (2002: 47%, 2017: 28%) and the contribution of hypertension (2002: 13%, 2017: 29%) and stroke (2002: 7%, 2017: 14%) increased (Figure 7). The other diseases were quite stable over the years. In 2002, 2007 and 2012 IHD, hypertension and breast cancer contributed most to the number of deaths attributable to physical inactivity whereas in 2017 hypertension, IHD and stroke contributed most. Low back pain, depression and osteoporosis contributed in all years the least.

Table 10: Both sexes, number of deaths attributable to physical inactivity in Switzerland

	2002				2007				2012				2017			
Disease	**Total deaths**	**IAM**	**IAM 95% CI lb**	**IAM 95% CI ub**	**Total deaths**	**IAM**	**IAM 95% CI lb**	**IAM 95% CI ub**	**Total deaths**	**IAM**	**IAM 95% CI lb**	**IAM 95% CI ub**	**Total deaths**	**IAM**	**IAM 95% CI lb**	**IAM 95% CI ub**
IHD	10034	790	429	1143	9028	659	351	962	7983	471	237	696	7102	355	190	523
Stroke	1438	125	88	159	1671	138	94	180	1692	113	76	152	3089	182	115	249
Hypertension	1294	224	192	259	1782	292	246	342	2221	303	248	355	3155	369	304	433
Type 2 diabetes	1489	146	94	196	1313	119	73	163	1090	80	51	111	1070	67	42	92
Breast cancer	1338	199	174	225	1272	168	145	192	1369	155	132	178	1359	134	113	156
Colon cancer	1136	155	140	170	1205	151	136	167	1178	121	108	135	1717	150	134	166
Osteoporosis	97	26	20	32	70	17	13	21	82	17	13	21	110	20	15	25
Low back pain	42	3	2	4	20	1	1	2	26	1	1	2	43	2	1	3
Depression	77	8	5	11	94	9	6	13	125	10	6	13	138	9	6	12
Total	16945	1678	1308	2038	16455	1556	1237	1871	15766	1272	1026	1510	17783	1287	1095	1483

Legend: IHD=Ischemic heart disease. IAM=Inactivity attributable mortality. Number of deaths for population older than 35 years

Table 11: Men, number of deaths attributable to physical inactivity in Switzerland

	2002				2007				2012				2017			
Disease	**Total deaths**	**IAM**	**IAM 95% CI lb**	**IAM 95% CI ub**	**Total deaths**	**IAM**	**IAM 95% CI lb**	**IAM 95% CI ub**	**Total deaths**	**IAM**	**IAM 95% CI lb**	**IAM 95% CI ub**	**Total deaths**	**IAM**	**IAM 95% CI lb**	**IAM 95% CI ub**
IHD	4928	315	139	490	4632	280	115	451	4221	203	79	331	3900	159	63	252
Stroke	630	45	28	61	718	49	30	68	737	40	23	59	1279	59	35	88
Hypertension	409	57	45	69	567	75	60	91	707	77	60	96	1034	93	75	115
Type 2 diabetes	629	49	29	72	576	43	23	62	515	31	17	45	556	28	15	44
Breast cancer	9	0	0	0	8	0	0	0	4	0	0	0	12	0	0	0
Colon cancer	560	64	56	73	632	70	59	80	599	51	44	59	930	70	60	81
Osteoporosis	5	1	1	1	8	2	1	2	6	1	1	1	18	2	2	3
Low back pain	17	1	1	2	9	1	0	1	12	1	0	1	12	0	0	1
Depression	17	1	1	2	19	1	1	2	41	2	1	4	43	2	1	3
Total	7204	534	356	712	7169	519	351	694	6842	406	279	537	7784	415	313	516

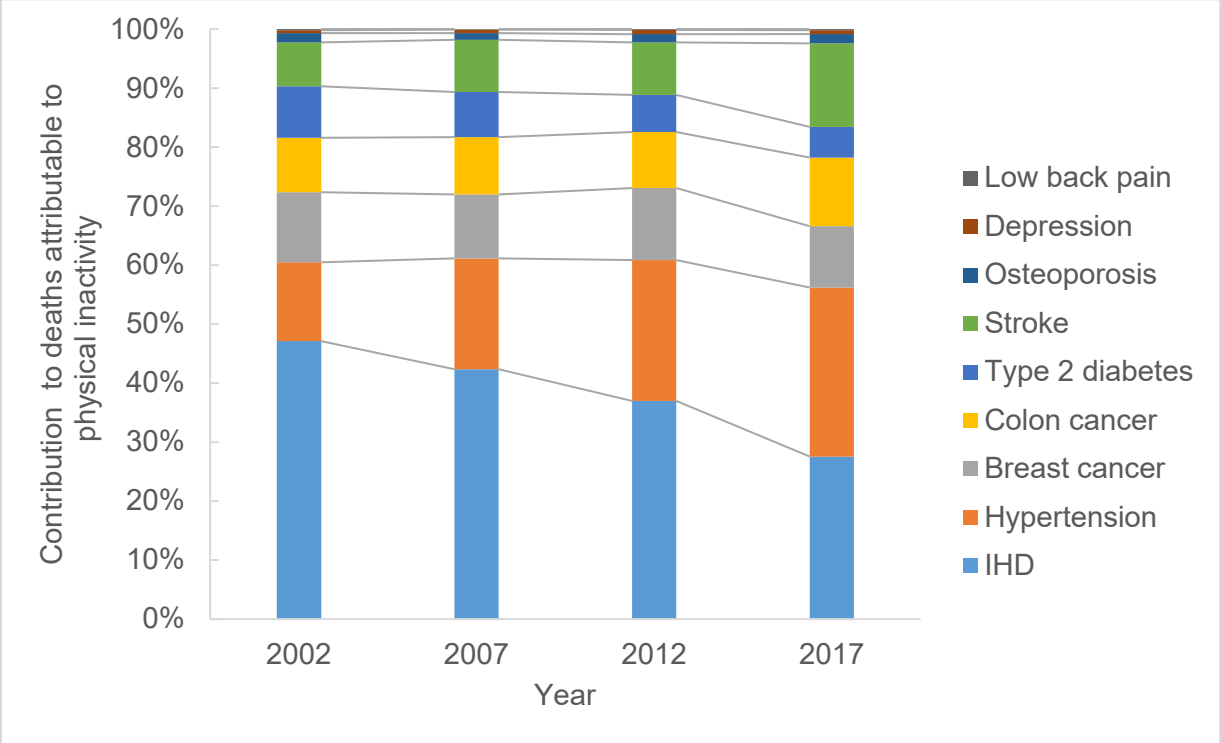
Legend: IHD=Ischemic heart disease. IAM=Inactivity attributable mortality. Number of deaths for population older than 35 years

Table 12: Women, number of deaths attributable to physical inactivity in Switzerland

	2002				2007				2012				2017			
Disease	**Total deaths**	**IAM**	**IAM 95% CI lb**	**IAM 95% CI ub**	**Total deaths**	**IAM**	**IAM 95% CI lb**	**IAM 95% CI ub**	**Total deaths**	**IAM**	**IAM 95% CI lb**	**IAM 95% CI ub**	**Total deaths**	**IAM**	**IAM 95% CI lb**	**IAM 95% CI ub**
IHD	5106	475	160	781	4396	379	119	629	3762	267	70	453	3202	196	62	336
Stroke	808	80	48	111	953	89	50	127	955	73	40	107	1810	123	61	183
Hypertension	885	167	138	200	1215	217	174	264	1514	226	174	275	2121	275	213	336
Type 2 diabetes	860	97	48	141	737	77	35	116	575	50	24	77	514	38	18	59
Breast cancer	1329	199	174	225	1264	168	145	192	1365	155	132	178	1347	134	113	156
Colon cancer	576	91	78	103	573	82	70	94	579	69	59	81	787	80	67	92
Osteoporosis	92	25	19	31	62	16	12	19	76	17	12	21	92	18	13	22
Low back pain	25	2	1	3	11	1	0	1	14	1	0	1	31	2	1	3
Depression	60	7	3	10	75	8	4	12	84	7	4	10	95	7	4	10
Total	9741	1144	820	1457	9286	1037	766	1298	8924	866	656	1064	9999	872	709	1040

Legend: IHD=Ischemic heart disease. IAM=Inactivity attributable mortality. Number of deaths for population older than 35 years

Figure 7: Contribution of the diseases to the deaths attributable to physical inactivity



Legend: IHD=Ischemic heart disease. Overview of all nine diseases included in the present study.

3.6 Plausibility check with all-cause mortality

In 2017, 65912 deaths from all causes occurred in the population 35 years and older and 5522 deaths from all causes were attributable to physical inactivity (Table 13 and Tables S3-S5; see section 2.8.2 for details regarding the methodological approach). These numbers are higher than the ones reported in section 3.4. Therefore, we likely underestimate the number of deaths attributable to physical inactivity when focusing on the following nine diseases: ischemic heart disease, stroke, hypertension, type 2 diabetes, breast cancer, colon cancer, osteoporosis, low back pain and depression. As mentioned in section 2.3, many more diseases have been associated with physical inactivity but we focused on the diseases for which RRs were available from systematic reviews and meta-analyses.

Table 13: Number of deaths in total population and number of deaths attributable to physical inactivity for all-cause mortality in Switzerland in 2017

	Men		Women		Both sexes	
	Total deaths	**Inactivity attributable deaths (% of total)**	**Total deaths**	**Inactivity attributable deaths (% of total)**	**Total deaths**	**Inactivity attributable deaths (% of total)**
All-cause mortality	31708	2171 (6.8%)	34204	3351 (9.8%)	65912	5522 (8.4%)

Legend: Number of deaths for population older than 35 years.

4. Discussion

4.1 Summary of results

In 2017, 1287 deaths (95% CI 1095-1483) were attributable to physical inactivity. These are 2% of the total deaths occurring in Switzerland in 2017. Cardiovascular diseases contributed 71% to the deaths attributable to physical inactivity and the two cancers, breast and colon, 22%. Most deaths occurred in the age group 75+. This is also where the prevalence of physical inactivity was highest. Consequently, this age group contributed most to the number of deaths attributable to physical inactivity. Furthermore, women caused substantially more deaths attributable to physical inactivity than men (68% vs. 32%). The temporal trend analysis showed a decrease in the number of deaths attributable to physical inactivity from 2002 to 2012 and a stabilization from 2012 to 2017.

4.2 Comparison to previous study

In a previous study conducted for the year 2011, 1152 deaths were attributable to physical inactivity [10]. These deaths amounted to 2% of the total number of deaths for that year. Therefore, this share of deaths attributable to physical inactivity remained constant between 2011 and 2017. This result was also supported by the temporal trend analysis that compared the year 2012 and 2017.

From a methodological point of view, the previous and the present study included similar diseases and similar ICD-10 codes were used to identify the deaths related to the included diseases in the SDS. In addition, both studies used the same definition of physical inactivity and the SHS to estimate the prevalence of physical inactivity. However, the RRs differed between the studies for most diseases as we focused in the current study on RRs from most recent systematic reviews and meta-analyses. For the two cancers and type 2 diabetes, the RRs used in the present study were higher compared to the previous study. For all other diseases, the RRs were lower in the present study. Furthermore, we used a different PAF formula to be consistent with recent studies estimating the deaths attributable to other behavioral NCD risk factors [23] which also allowed us to estimate age and sex group specific PAFs in the present study.

4.3 Strengths of the study

The present study had several strengths:

- We used most recent data to estimate the prevalence of physical inactivity (SHS) and the number of deaths in the total population (SDS).
- The RRs were derived from most recent systematic reviews and meta-analyses and they are all adjusted for confounders.
- Age and sex group specific prevalence of physical inactivity, PAFs and numbers of deaths were used.
- Uncertainty was addressed in a PSA.

4.4 Limitations of the study

The present study had also several limitations:

- The RRs we used were not based on a consistent definition of physical inactivity.
- Sex and age specific RRs were not available, so we used the same RRs among sex and age groups.
- The SHS includes self-reported physical activity levels. There are studies from Switzerland showing that time spent physically active was substantially higher according to self-reported questionnaires than measured with accelerometers [24, 25].
- Regional (language region specific) differences in prevalence of physical inactivity and number of deaths were not considered.
- Deaths related to physical activity (physical activity related deadly accidents) were not considered.
- The results for all-cause mortality indicate that we likely underestimate the deaths attributable to physical inactivity when focusing on the nine diseases included in the present study and that there are more diseases associated with physical inactivity.

5. Conclusions

A substantial number of 1287 deaths (95% CI 1095-1483) were attributable to physical inactivity in Switzerland in 2017. Hypertension was the disease that contributed most to these deaths (29%) followed by IHD (28%). Most deaths occurred in the age group 75+. This is also where the prevalence of physical inactivity was highest. Consequently, this age group contributed most to the number of deaths attributable to physical inactivity and women contributed twice as much deaths as men. The temporal trend analysis showed a decrease of the number of deaths attributable to physical inactivity from 2002 to 2012 and a stabilization from 2012 to 2017. Policy makers should aim to further increase physical activity in general and specifically in the age group 75+, especially in women.

6. References

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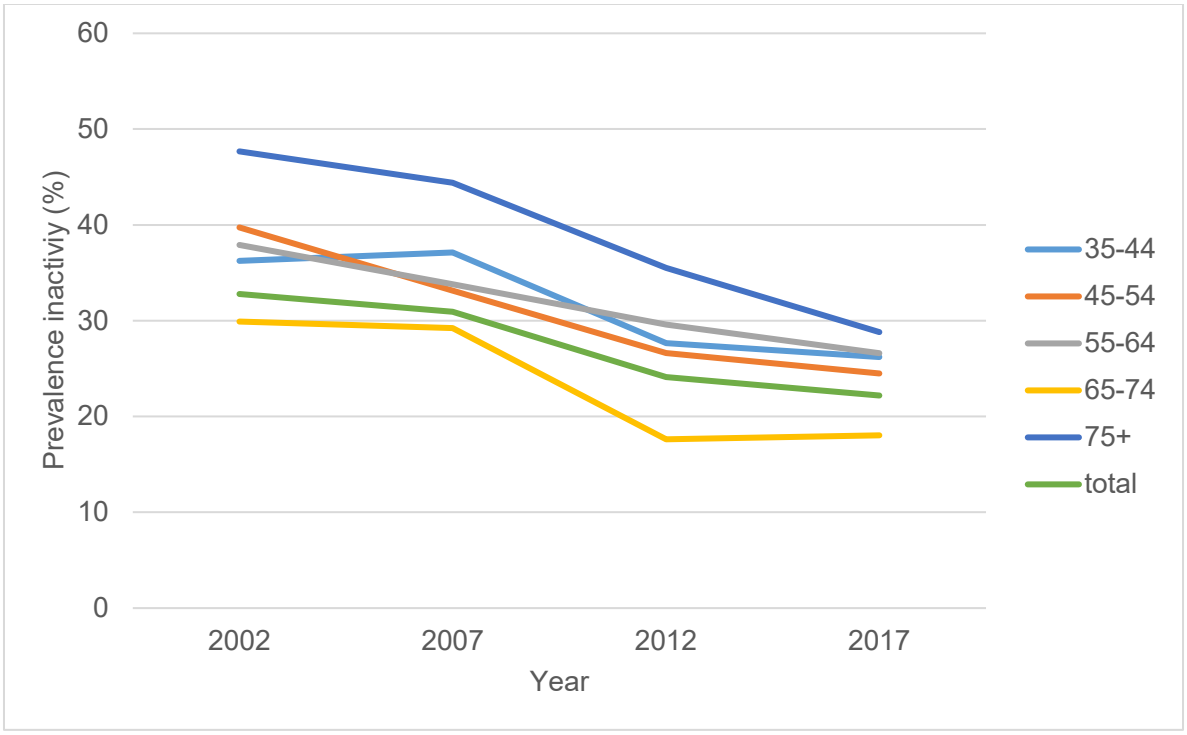
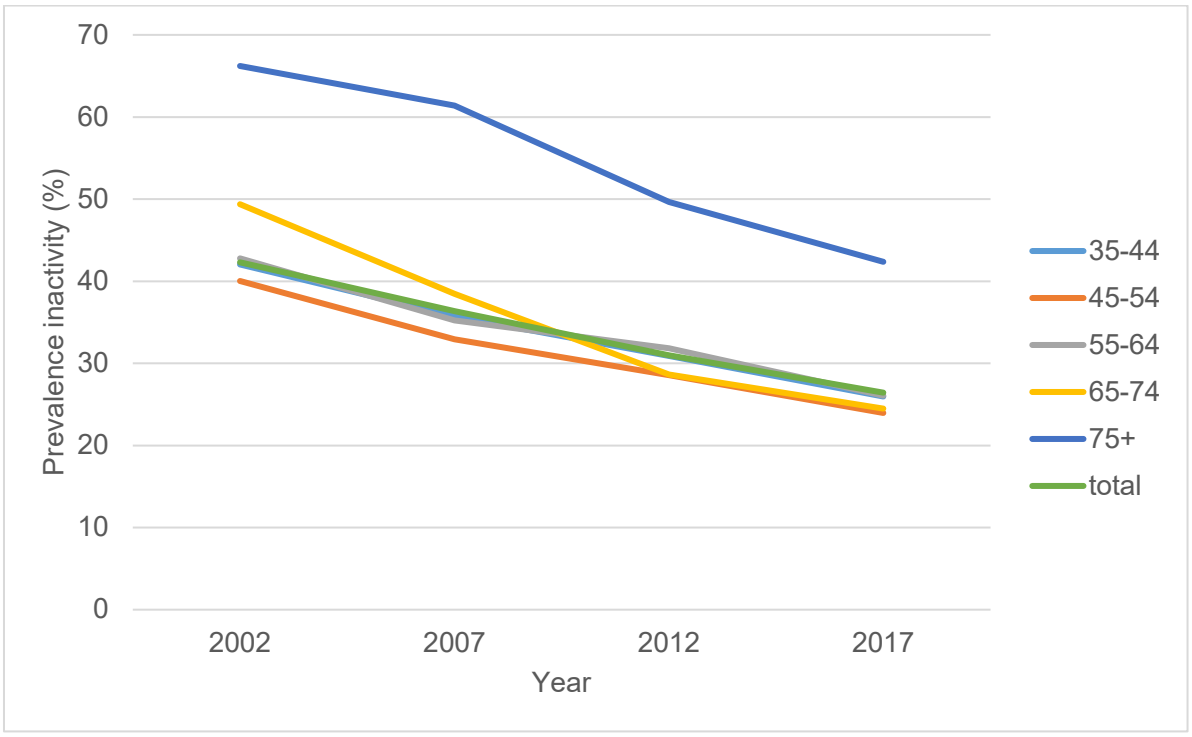
7. Supplementary appendix

Figure S1: Men, prevalence of physical inactivity based on the Swiss Health Survey



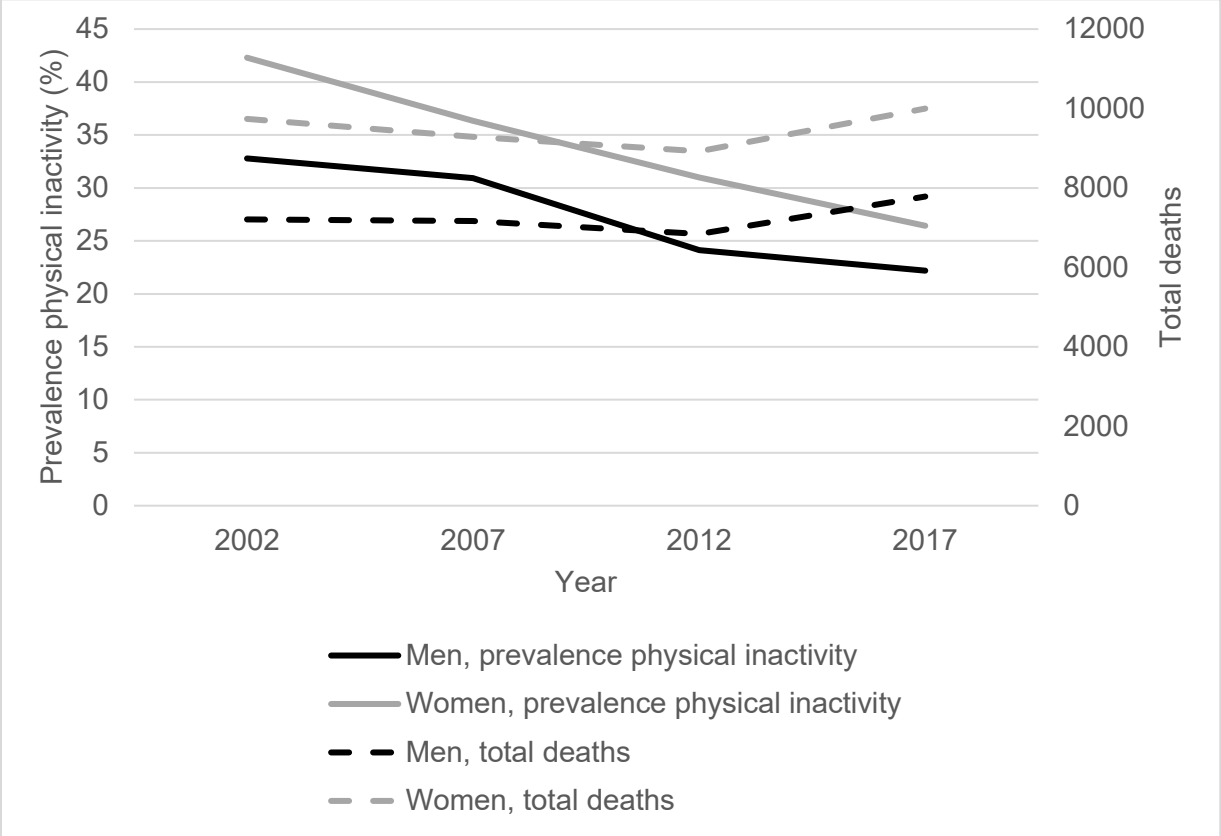
*Legend: * age 15+ years*

Figure S2: Women, prevalence of physical inactivity based on the Swiss Health Survey



*Legend: * age 15+ years*

Figure S3: Prevalence of physical inactivity and number of deaths in total population



Legend: Prevalence age 15+ years. Total deaths age 35+ years. Total deaths include deaths from ischemic heart disease, stroke, hypertension, type 2 diabetes, breast cancer, colon cancer, osteoporosis, low back pain and depression. Prevalence is based on the Swiss Health Survey. Deaths in total population are based on the Swiss Death Statistics and are not standardized

Table S1: Men, Number of people and rate of deaths attributable to physical inactivity in Switzerland per age group and year (rounded numbers)

Men	2002		2007		2012		2017	
Age group	**Population**	**IAM Rate***	**Population**	**IAM Rate***	**Population**	**IAM Rate***	**Population**	**IAM Rate***
35-44	609689	0.97	611798	0.74	580224	0.54	592469	0.47
45-54	510047	3.76	559589	2.76	639781	1.80	659965	1.86
55-64	419861	10.76	462661	9.12	487907	6.67	548915	5.91
65-74	277575	27.91	306162	21.26	361589	10.09	401930	11.70
75+	215178	179.44	242043	161.95	272634	118.30	317032	101.10
Total	2032350	26.27	2182253	23.80	2342135	17.34	2520311	16.47

*Legend: *Age- and sex-standardized inactivity attributable mortality rate per 100000*

Table S2: Women, Number of people and rate of deaths attributable to physical inactivity in Switzerland per age group and year (rounded numbers)

Women	2002		2007		2012		2017	
Age group	**Population**	**IAM Rate***	**Population**	**IAM Rate***	**Population**	**IAM Rate***	**Population**	**IAM Rate***
35-44	601520	1.52	608726	1.13	577051	0.74	582501	0.68
45-54	504132	5.19	550772	3.45	625195	2.89	646873	2.35
55-64	427827	12.57	467465	8.67	489033	7.19	544691	5.27
65-74	330801	33.94	347474	22.54	395272	14.56	433378	13.61
75+	373670	252.18	401609	222.16	425535	176.38	461252	165.87
Total	2237950	51.11	2376046	43.64	2512086	34.46	2668695	32.67

*Legend: *Age- and sex-standardized inactivity attributable mortality rate per 100000*

Table S3: Population attributable fractions due to physical inactivity and 95% CI for all-cause mortality by sex and age group in Switzerland in 2017

	35-44			45-54			55-64			65-74			75+		
	PAF	**95% CI lb**	**95% CI ub**	**PAF**	**95% CI lb**	**95% CI ub**	**PAF**	**95% CI lb**	**95% CI ub**	**PAF**	**95% CI lb**	**95% CI ub**	**PAF**	**95% CI lb**	**95% CI ub**
Men	0.068	0.050	0.090	0.064	0.046	0.083	0.069	0.050	0.089	0.048	0.034	0.063	0.075	0.055	0.097
Women	0.068	0.050	0.086	0.063	0.046	0.081	0.068	0.050	0.087	0.064	0.047	0.082	0.106	0.079	0.133

Legend: The upper and lower bound for the 95% CI of the PAF were acquired from the probabilistic sensitivity analysis

Table S4: Number of deaths in total population for all-cause mortality by sex and age group for Switzerland in 2017

	35-44	**45-54**	**55-64**	**65-74**	**75+**	**Total**
Men	486	1503	3145	6025	20549	31708
Women	283	843	1756	3867	27455	34204
Total	769	2346	4901	9892	48004	65912

Table S5: Number of deaths attributable to physical inactivity and 95% CI for all-cause mortality by age group (rounded numbers) in Switzerland in 2017

	35-44			45-54			55-64			65-74			75+		
	deaths	**95% CI lb**	**95% CI ub**	**deaths**	**95% CI lb**	**95% CI ub**	**deaths**	**95% CI lb**	**95% CI ub**	**deaths**	**95% CI lb**	**95% CI ub**	**deaths**	**95% CI lb**	**95% CI ub**
Men	33	24	44	96	69	125	218	157	279	289	203	381	1534	1125	1993
Women	19	14	24	53	39	69	119	88	153	248	181	319	2911	2163	3664
Total	52	42	64	149	119	182	338	269	407	538	429	653	4445	3593	5327

Legend: Differences in total due to rounding