

The Swiss army knife impact study: a survival analysis

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Abstract

Introduction: Life expectancy varies substantially among countries and is influenced by many factors. The Swiss army knife, a genius tool which has been designed to improve life conditions and potentially to help surviving in challenging environments, might be associated with increased life expectancy. In this study we aimed to assess the relationship between life expectancy and rates of Swiss army knife purchase, a surrogate of the use of Swiss army knives at a population level.

Method: Ecological study assessing the association between the purchase of Swiss army knives and healthy life expectancy. To take into account socio-economic status, stratified analyses were conducted separately in low income and high income countries.

Results: Data from 41 countries were retrieved from the historical Swiss army knife manufacturer. A strong and linear association was found between rate of purchase of Swiss army knives and life expectancy ($r=0.43$, $p< 0.05$). A positive association was also found in stratified analyses for high and low income countries (resp. $\beta=0.11$, $p=0.043$ and $\beta=1.81$, $p=0.009$). The life expectancy of the population increases by a healthy year for every 0.6, respectively 9.1, Swiss army knives purchased per 10'000 inhabitants.

Conclusion: This ecological study suggests that the use of Swiss army knives is associated with increased life expectancy in both high and low income countries. Governments should adopt strategies to increase the rate of purchase of Swiss army knives and could thus contribute to decrease health disparities between countries.

Introduction

Life expectancy at birth has long been the primary indicator used to compare global population health between countries¹. Numerous factors influence a population's overall life expectancy, including not only infant mortality and rates of disease, but also more indirectly a country's wealth, degree of social inequality and political stability^{2 3}. Indeed, countless determinants have been identified, with a greater or lesser influence on overall life expectancy.

The World Health Organization has made it one of its 2014-2019 strategic priorities to address social determinants and inequity in health⁴. However many determinants of socio-economic status, such as ethnicity and gender, may in fact simply be predictors of a key intermediate factor: the possession of a multi-utility Swiss army knife (MUSK). The MUSK represents a potent tool, weapon and device, all contained within a compact, practical design, and could increase survival through multiple mechanisms. What if countries with greater wealth and purchasing power are healthier *because* of their greater ability to purchase MUSKs?

To the best of our knowledge no studies have to date assessed the impact of MUSKs on life expectancy. There are numerous informal case reports of a MUSK allowing people to survive otherwise fatal situations⁵. Many authors in sciences have borrowed the image of the MUSK to illustrate the pluripotent outcomes or excellence of their technique^{6 7}. However, the MUSK *per se* has never been studied despite a global spread since its invention in 1884⁸.

In this ecological study named the Swiss army Knife Impact on Survival (SKIS) study, we set out to explore the relationship between rates of MUSK purchase and life expectancy. We hypothesize that people living in countries with a greater number of MUSKs will have greater longevity.

Method

Data collection

Our objective was to obtain the data for all MUSKs sold in Switzerland and those exported abroad. We also intended to get data about the nationality of people buying their knife in Switzerland, in order to make an assumption about the total quantity of exported MUSKs (including those bought by tourists).

We defined the MUSK as the basic multi-utility Swiss army knife and considered the sales figures of Victorinox AG because this is the exclusive supplier of multi-tool pocket knives for the Swiss army and these knives are distributed in more than 100 countries on all five continents⁸.

Because no official sales figures are published, an investigator contacted Victorinox AG in January 2015 by phone and mail to obtain the sales figures for MUSKs. In order to facilitate the data generation, we were asked to restrain the number of countries we were interested in, to a number of 30-40 countries. Based on the life expectancy statistics of the WHO 2014, the 10 most populous countries (latest available population data: 2012) in 4 income categories were selected: high, middle-upper, middle-lower and low (same year as population data: 2012). Low income countries were countries with low-income (gross national income per capita $\leq 1,045$ \$) or lower-middle-income (gross national income per capita $< 4,125$ \$) in the World Bank classification. High income countries were countries with upper-middle income (gross national income per capita $\geq 4,125$ \$) and high income according to the World Bank classification (gross national income per capita $\geq 12,746$ \$). As Switzerland didn't figure in this list, we added it for the purpose of comparison (cf. table 1).

In order to correct the number of MUSKs sold in Switzerland by foreign tourists, four main retailers were contacted, as they might be able to give us information about their clients' origin and two of them agreed to send us their confidential data, while two others didn't answer. The

data was thus obtained from four shops in the German speaking part of Switzerland, one shop online, and one shop in the French speaking part of Switzerland. Thereby a correction factor to exclude the proportion of non-Swiss buyers was calculated and applied on the total figure of MUSKs sold in Switzerland. Data for Switzerland were corrected to represent the number of MUSK sold to Swiss citizens only (2.1 % of the total MUSK sold in the country).

The total population and the healthy life expectancy (HALE) data from the Population and Development Database provided by the Department of Economic and Social Affairs of the United Nations ^{9 10} were considered for testing our hypothesis.

Statistical analyses

The dependence between HALE and the number of MUSKs sold per 10'000 inhabitants was measured by the Pearson's correlation. Ecological regressions were then performed to test the association between HALE, the dependant variable, and the number of MUSKs sold per 10'000 inhabitants, the independent variable. To take into account socio-economic status, stratified analyses were conducted separately in low income and high income countries. Analyses were performed using Stata 13 software.

Results

Sales data for 41 different countries are presented in Table 1, with respect to gross national income per capita based on their position in the World Bank income group for 2015.

The linearity of the relation between the number of MUSK per 10'000 inhabitants and the HALE was sufficient for a linear regression (Pearson's correlation, $r = 0.43$, $p < 0.05$).

Graphical assessment retrieved one outlier "Germany" (Supplemental online figure 1). This outlier was eliminated from the subsequent analyses (Figure 1).

Results from the linear regression analysis performed on both classes of income showed a significant positive relation between the HALE and the number of MUSKs per 10'000 inhabitants (Table 2, model 2). The overall model was adequate ($F(1, 38) = 21.57$, adjusted R-squared: 0.35). The life expectancy of the population increases by a healthy year for every 4.2 MUSKs purchased per 10'000 inhabitants.

To define the linear relation between HALE and MUSKs per 10'000 inhabitants in more details, we conducted analyses stratified by income groups. The linear relation between the HALE and the number of MUSKs per 10'000 inhabitant remained significant for both groups (Table 2, models 3 and 4). Both were adequate (model 3: $F(1, 18) = 4.75$, adjusted R-squared: 0.16; model 4: $F(1, 18) = 8.69$, adjusted R-squared 0.33). For low and high income countries, the life expectancy of the population increases by a healthy year for every 9.1 and 0.6 MUSKs purchased per 10'000 inhabitants, respectively.

Discussion

This study shows that people living in countries with a greater number of MUSKs have a greater healthy life expectancy. Interestingly, this association is present not only for high income, but also low income countries. Using the set of features described by Sir Austin Bradford Hill in 1965, our results suggest that this association is substantial¹¹.

Biological plausibility: the multiple tools of the Swiss army knife are likely to provide some survival capacities to persons who own one. This compact multifunction tool promotes an outdoor life style and thus physical activity, whose health benefits are well demonstrated¹². Besides the obvious use as a weapon for protection, the MUSK facilitates healthy diet: the corkscrew enables wine consumption in diverse locations, and regular moderate wine

consumption seems to confer cardiovascular protective effects¹³, while the can opener promotes intake of better types of lipids, including omega 3s, by substituting meat or cheese sandwiches by canned tuna or sardine fish¹⁴. The toothpick is useful for preventing periodontal disease, and as there is growing evidence of the association of periodontal disease and cardiovascular diseases¹⁵, this Swiss army knife tool could also play a role in life expectancy. Some tools of the MUSK can also improve survival in a difficult environment. The saw is useful to build shelter for hikers lost in the wilds, a shelter of extreme importance as demonstrated by the WHO reports about social determinants of health^{16 17}. The knife can be useful in some medical emergency situations as for tracheotomy. One other medical use may be abscess incision in order to clear the infection and prevent it from spreading. While MUSKs are associated with inherent risks, such as the accidental folding of the knife on one's finger, its stainless iron blade appears to be protective against superinfection of wounds and therefore unlikely to cause death. Indeed, while we were able to find numerous reports on accidental folding of the knife leading to visits to an EMR (including anecdotal examples from members of the research group), we were unable to find any case report on a fatality due to MUSK.

Strength: we found a significant relation between MUSKs and healthy life expectancy (Pearson's correlation, $r=0.43$, $p<0.05$). A linear regression performed on low and high income countries shows a significant positive relation on both classes.

Dose-response: the linearity of the relation between the number of MUSKs per 10'000 inhabitants and the HALE in 40 countries suggest a dose-effect relationship.

Consistency: the analysis considered 40 countries data. The association remained significant when we stratified by income groups.

Analogy: this is the second study showing that a Swiss quality product can induce a positive impact on life expectancy. A study published in the New England Journal of Medicine found a

correlation between chocolate intake per capita and the number of Nobel laureates¹⁸. Moreover, data showed that life expectancy of the Nobel prizewinners in physiology or medicine is increased as compared with the male population of USA¹⁹.

Limitations

Our study has several limitations. First, we lacked information concerning how many functions were available for each MUSK, from the smaller to the bigger model. We were not able to identify which of the multiple tools in the knife would have the most important impact on mortality. The knowledge of how many functions per MUSK should give us the possibility to stratify per function and evaluate if there is a dose-dependent relationship, with more complex, highly potent MUSKs having an even greater impact on survival. Second, this is an ecological study where exposure is known only for the groups, not for the individuals of the groups with the risk of ecological fallacy. In addition, temporality criterion is not possible to explore nor temporality neither specificity. For that, a randomized controlled trial, cohort or longitudinal studies would be necessary. The study design doesn't allow us to test the reversibility because the knife life expectancy is everlasting. Finally Germany data were excluded from the linear regression analysis. Our hypothesis is that the geographic location of Germany is very similar to Switzerland. Thus, foreign tourists who visit throughout Europe in just a few days could buy their MUSK in Germany rather in Switzerland for convenience reasons. Unfortunately, we were not able at the time to adjust the sales figures of Germany to analyze only domestic purchases.

Implications

Through this original study, we moved from the expert opinion (historical works from Sir Mac Gyver) to a possible causality association between MUSK and survival, with a very concrete public health indicator of the life expectancy of a population.

Future research

To upgrade the level of proof and the individual impact, it seems important to realize cohort studies to appreciate events through a long time follow up as done by Peto and Doll²⁰ for mortality related to smoking as randomized controlled trials comparing populations with and without possession of a MUSK and the impact on their life expectancy. In complement, focus groups should be conducted in several countries with different rate of incomes to better understand the use of MUSKs and explain the significant linear correlation between rate of purchase of MUSKs and HALE.

In the meanwhile, we highly recommend that Governments consider the use of MUSKs to increase the life expectancy of their population and thus contribute to decreasing health disparities.

Patients' involvement

Because of its ecological design, this study did not involve patients at any stage. Data collection and analysis staying at a population level.

Competing interests

All authors own one or more Swiss army knives. However they all confirm that they do not own any stocks or have any relationship with Victorinox AG.

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Table 1: Number of multi-utility Swiss army knives per 10'000 habitants by country (N=41).

Country (n=21)	Number of units per 10'000 inhabitants	Country (n=20)	Number of units per 10'000 inhabitants
<u>High income#</u>		<u>Low income#</u>	
Algeria	4.26	Afghanistan	0.00
Argentina	9.87	Bangladesh	0.00
Brazil	5.65	China	7.76
Canada	57.94	Democratic Republic of the Congo	1.18
Colombia	9.93	Egypt	0.17
France	48.53	Ethiopia	0.35
Germany	250.95	India	0.52
Italy	22.61	Indonesia	0.82
Japan	18.62	Iran (Islamic Republic of)	4.30
Mexico	37.87	Kenya	0.34
Peru	8.28	Myanmar	0.03
Poland	41.97	Nigeria	0.04
Republic of Korea	19.92	Pakistan	0.54
Russian Federation	26.54	Philippines	2.63
Saudi Arabia	4.84	Thailand	2.13
South Africa	10.93	Uganda	0.00
Spain	23.76	Ukraine	5.73
Switzerland	88.78°	United Republic of Tanzania	0.06
Turkey	5.43	Uzbekistan	2.52
United Kingdom of Great Britain and Northern Ireland	35.72	Viet Nam	0.23
United States of America	55.00		

° corrected by the rate of domestic purchases.

Low income countries were countries with low-income (gross national income per capita \leq 1,045\$) or lower-middle-income (gross national income per capita $<$ 4,125\$) in the World Bank classification. High income countries were countries with upper-middle income (gross national income per capita \geq 4,125\$) and high income according to the World Bank classification (gross national income per capita \geq 12,746\$)

Table 2: Association between multi-utility Swiss army knives and the healthy life expectancy

Linear regression			
Swiss army knives	Healthy life expectancy		
	β (SE)	p	adjusted r-squared
Model 1 (all countries)	0.08 (0.03)	0.006	0.16
Model 2 (without Germany)	0.24 (0.05)	$<$ 0.001	0.35
Model 3 (Low income)	0.11 (0.05)	0.043	0.16
Model 4 (High income)	1.81 (0.62)	0.009	0.29

β : non standardized coefficient.

SE=standard error of the regression coefficients (β).

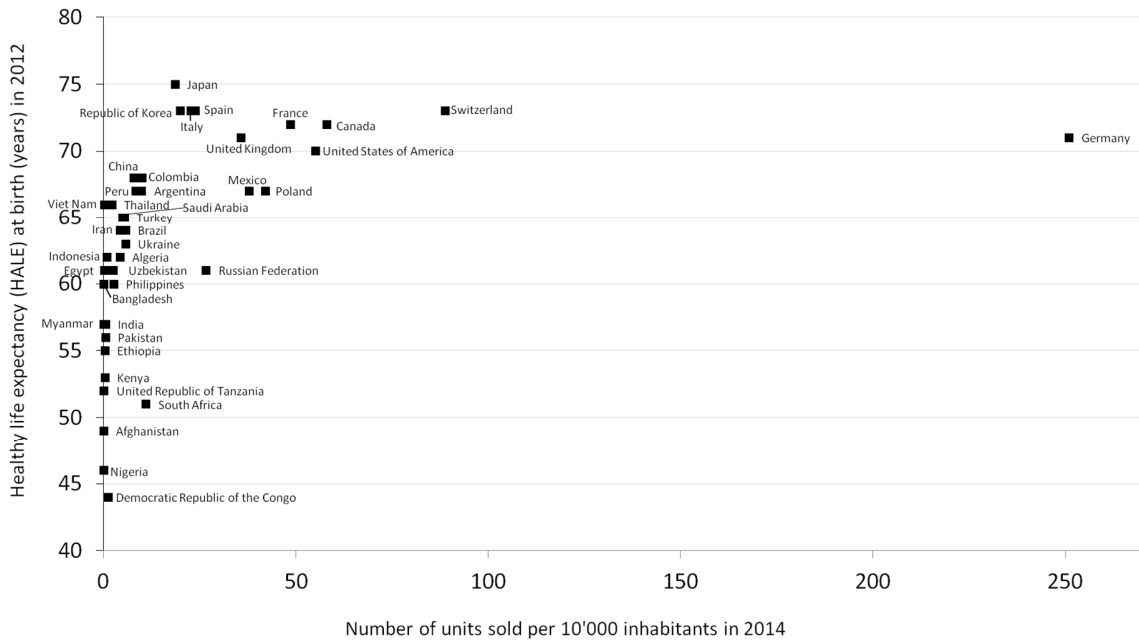


Figure for online publication : Correlation between multi-utility Swiss army knives and the healthy life expectancy (corrected for Switzerland).

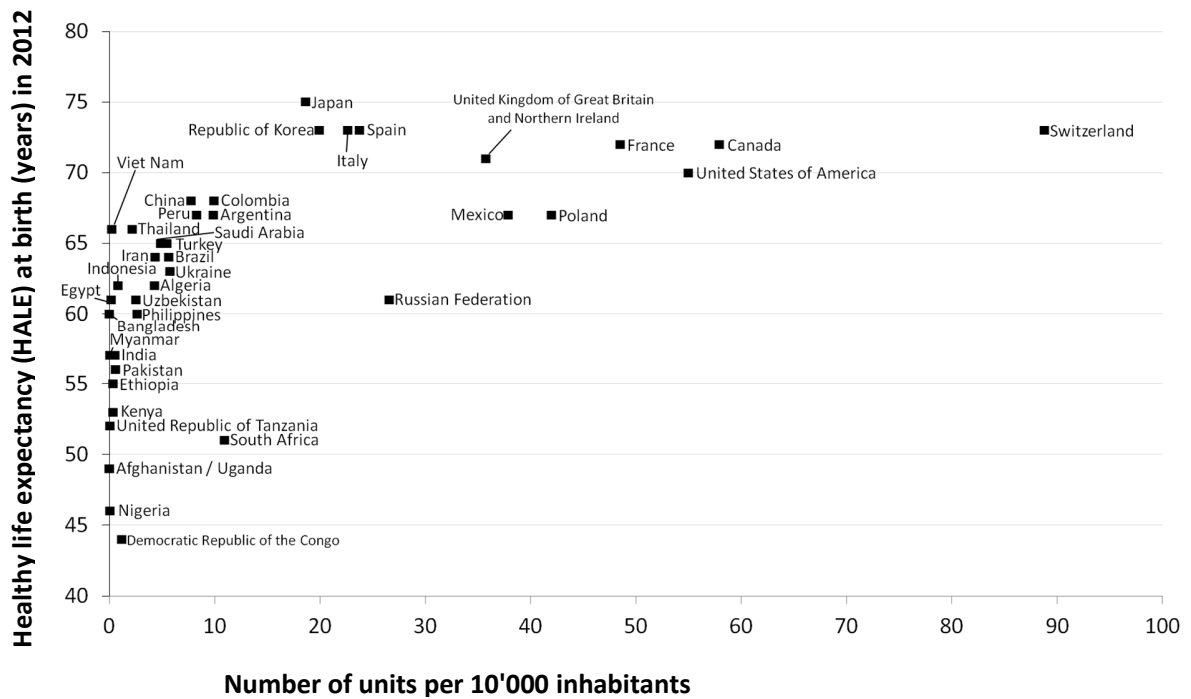


Figure 1 : Correlation between multi-utility Swiss army knives and the healthy life expectancy (without Germany; corrected for Switzerland).