The Swiss-SEP neighbourhood index of socioeconomic position: Update

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ABSTRACT

Background The Swiss neighbourhood index of socioeconomic position (Swiss-SEP) was published in 2012, based on neighbourhoods of 50 households and data from the 2000 census on rent, education and occupation of the household head, and crowding. We developed updated Swiss-SEP versions and validated them against income and mortality data.

Methods We replicated the 2012 analyses, creating a new index based on the micro censuses 2012-2015. We used principal component analysis on neighbourhood-aggregated indicators and standardised the index to a range of 0-100. We also created a hybrid version, with updated values for neighbourhoods centred on buildings constructed after 2000 and original values for remaining neighbourhoods.

Results Analyses were based on 1.54 million neighbourhoods, with 892,129 households captured in the micro censuses. The distance by road between reference and other buildings of neighbourhoods doubled. All three versions of the Swiss-SEP index (old, new, hybrid) correlated well with household income and mortality.

Conclusion The Swiss-SEP index captures area-based SEP at a high resolution. The hybrid version maintains a high spatial resolution while adding information on new neighbourhoods. The indices allow the study of SEP when data on individual-level SEP are missing, or area-level effects are of interest.

Keywords: Switzerland, socioeconomic position, social inequalities in health, mortality

RESEARCH IN CONTEXT

What is already known on this subject?

- The Swiss-SEP index of neighbourhood socioeconomic position (SEP) has been successfully used in many studies examining health-related outcomes in Switzerland.
- The index is based on the national census 2000 and was validated against independent income data from the Swiss Household Panel (SHP). It was strongly associated with mortality 2001 to 2008.
- There is a need to re-evaluate the performance of the original index and consider a possible update within a changed national statistics landscape.

What this study adds?

- We created a new Swiss-SEP index using the yearly micro censuses that replaced the decennial house-to-house census.
- We also created a hybrid version of the Swiss-SEP where we updated values for neighbourhoods centred on buildings constructed after 2000.
- We validated the old and new indices against the updated SHP data to assess the association with income and against mortality over the period 2012 to 2018.
- All three versions of the Swiss-SEP index (old, new, hybrid) correlated well with household income and mortality. The Swiss-SEP index will continue to be useful in health-related research in Switzerland.

INTRODUCTION

Swiss neighbourhood index of socioeconomic position (Swiss-SEP) was published in 2012 [1], based on neighbourhoods of about 50 households with overlapping boundaries and data on rent per square metre, education and occupation of the household head, and crowding [1]. One hundred and five studies across various domains cited this work, with over sixty applying the index in analyses across various fields of epidemiologic research. The index been used in studies of mortality, life expectancy, assisted suicide, various environmental exposures, smoking, obesity, high blood pressure, physical activity, birth weight, cancer, HIV, amyotrophic lateral sclerosis, adolescent health, preference-sensitive and end of life care, organ donation and randomised trials [Supplementary Material 1].

The index is based on the 2000 Population Census. There are concerns the situation might have changed since then, and that the measure has become increasingly out-of-date, at least for some applications or questions. The SEP of neighbourhoods tends to be relatively stable over time. Still, over the past two decades, Switzerland's population grew, and some areas might have changed their status, for example, due to the construction of new residential areas, the "gentrification" of existing areas, or new roads or public transportation links.

In 2010, Switzerland moved from decennial censuses to a yearly, registry-based census system.[2] Full demographic data on the resident population and data on residential buildings are available. However, much of the information at the level of individuals used to construct the Swiss-SEP, e.g. education or occupation, or households, e.g. rent, is no longer collected for the entire population. This new situation prevents a simple update of the index using the same methodology [1] on a new dataset. The registry data are supplemented by yearly micro censuses, collecting detailed data on a representative sample of approximately 200,000 residents.

This paper aims to describe the new Swiss data ecosystem, construct new versions of the Swiss-SEP index and validate the old and new versions against recent income data from the Swiss Household Panel [3] (SHP) and mortality data from the Swiss National Cohort [4] (SNC).

METHODS

To develop the revised version of the index we followed the five steps undertaken in the original work: (1) the definition of neighbourhoods, (2) the characterisation of neighbourhoods, (3) the construction of the index, (4) the validation of the index and (5) the analysis of association with mortality. Full details of the data preparation steps, including data sources, exclusion and inclusion criteria and final size of constructed datasets are provided in the Supplementary Material 2.

Definition of neighbourhoods

Like during the development of the original index, we used all residential buildings in Switzerland as the centres of neighbourhoods. We then collected the data from four annual waves of the micro censuses 2012 to 2015. We decided against using data from 2010 and 2011, the two first micro censuses, due to data quality issues and missing variables. The combined dataset from the four micro censuses allowed us to replicate the original procedure for defining and characterising neighbourhoods. Naturally, using a sample of buildings instead of the complete registry necessitated enlarging the size of neighbourhoods to reach the threshold of including 50 closest households, thus reducing resolution.

Socioeconomic standing of neighbourhoods

We used the same four domains that were the basis of the original index to describe neighbourhoods. Housing and income domains remained unchanged, based on the rent per square metre and crowding.[1] The micro census did not collect data on the head of the household. Instead, we used the information on the adult respondent from the household. Additionally, the original categorisation of occupations was not available for all survey years. We, therefore, used information from the International Standard Classification of Occupations [5] to categorise occupations.

Construction of the index

We constructed the index in the same manner as in 2012 using principal component analysis on neighbourhood aggregated indicators retaining the first component and standardising the index to a range of 0 to 100.[1]

Combination of indices

Apart from constructing the entirely new index, we also created a hybrid version of the index, with updated values for neighbourhoods centred on buildings built after 2000 and the original value of the index for the remaining neighbourhoods.

Validation using household panel data

We re-examined the construct validity of the index by exploring its association with income in the Swiss Household Panel (SHP), a longitudinal study following a random sample of Swiss households.[3] We combined data from the three recruitment waves (1999, 2004, 2013) and follow-up to 2015 of the SHP. We geocoded the residences of 8,151 (97.5%) of the survey participants that completed the questionnaire in 2013. We used the same variables as during the original study.[1] Information about equivalised income was available for 7,026 (86.2%) participants.

Mortality across deciles of indices

Finally, we updated all-cause and cause-specific mortality analyses as described previously [1], based on 304,000 deaths from 2012 to 2018 among 5.25 million individuals aged 30 or older. We used proportional hazard regression to estimate associations. We could not reproduce the adjusted models because the data about individual-level occupation and education was

missing. Analyses were performed using Stata (version 15, Stata Corporation, College Station, TX, USA), R (version 4.0.4, [6]) and ArcGIS software (version 10.5, Environmental Systems Research Institute. Redlands, CA, USA). This study was conducted within the framework of the Swiss National Cohort, with ethics approval from the Ethics Committee of the Canton Bern (No. 153/2014).

RESULTS

Analyses were based on 1.54 million neighbourhoods, with 892,129 households captured in one of the micro censuses. The median of the mean distance by road between the reference building and the other buildings within the neighbourhood increased from 131 m to 272 m. The first principal component retained to construct the index explained 48.9% of the total variance with similar loadings compared to the ones obtained in the initial work.[1] The hybrid version of the index retained values of the original index for 1.31 million neighbourhoods and updated it for 235,161 (15.3%) areas centred on the buildings constructed after 2000. Further details are provided in Supplementary Material 3.

All three versions of the Swiss-SEP index (old, new, hybrid) correlated well with the yearly equivalised household income from the SHP (**Figure 1**). For instance, the median income of the hybrid index rose from 48,000 CHF among households in the 1st Swiss-SEP decile to 75,000 CHF in the 10th decile. Associations with the other financial characteristics analysed were also closely similar to the original analysis [1] (Supplementary Material 3).

The updated Swiss-SEP indices were associated with all-cause and cause-specific mortality (**Figure 2**). Analyses were based on 33.6 million years of follow up. The age- and sex-adjusted hazard ratios (HR) of all-cause mortality comparing areas in the lowest decile of Swiss-SEP with areas of the highest decile were 1.39 (95% CI 1.36 to 1.41), 1.31 (95% CI 1.29 to 1.33) and 1.38 (95% CI 1.36 to 1.41) using the old, new and hybrid indices, respectively. Slightly stronger associations were observed after including nationality, civil status, language region and level of urbanisation in the model. The gradients remained in the analyses of cause-specific mortality (Supplementary Material 3).

DISCUSSION

We updated the Swiss-SEP index and created an entirely new version based on the micro-census data, with reduced spatial resolution, and a hybrid version that uses the old values of the index for buildings constructed up to 2000 and new values for buildings constructed since then. We demonstrated the feasibility of creating the new index using a more limited amount of information than the 2000 national house-to-house census. We also confirmed the persisting, strong gradient of SEP differentials in all-cause and cause-specific mortality in Switzerland.

Despite the limited amount of data available on the national level in Switzerland, we were able to replicate our earlier work using administrative and survey data and thus demonstrated the feasibility of updating the Swiss-SEP using the micro census data that have become available since 2010. The three versions of the area-based Swiss-SEP index appear to be similarly valid. The hybrid version maintains the high spatial resolution of the old version while adding information on new neighbourhoods around buildings constructed since 2000.

There have been few developments regarding high-resolution area-based SEP measures in Switzerland. Commercially available, but to our knowledge unvalidated data on purchasing power are available for municipalities.[7] However, our earlier work demonstrated that such a high level of aggregation weakens associations with health-related outcomes. Some recent developments in the use of alternative data sources such as housing characteristics [8], car registrations [9], mobile phone data [10], or social media [11] might offer opportunities for new developments. Similarly, the availability of yearly micro census offers the potential for updating indices more frequently .[12]

The new versions of Swiss-SEP inherited the limitations inherent in the original work. Switzerland still does not have access to any high resolution and high coverage data about income at the individual level. Such data are inherently difficult to obtain in the Swiss context. In the absence of access to other sources of data on income, rent remains the only viable alternative. To combine indices, we continued to rely on principal component analysis for creating the index. Other methods are available, but there is no consensus on best practice or guidelines for developing such measures.

In conclusion, all three versions of the area-based Swiss-SEP index capture SEP at a high resolution. The indices continue to offer the potential of studying SEP whenever data on individual-level SEP are missing or the contextual effect of area-based SEP is of interest. We will make all three versions of the Swiss-SEP index available to interested researchers.

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COMPETING INTERESTS

The authors declare that they have no competing interests.

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DATA ACCESS

The data are the property of the Swiss Federal Statistical Office (SFSO) and can only be made available by legal agreements with the SFSO. This also applies to derivatives such as the analysis files used for this study. However, after approval of the SNC Scientific Board, a contract with the SFSO allows researchers to receive analysis files for replication of the analysis. Data requests should be sent to Prof. Milo Puhan (chairman of the SNC Scientific Board, miloalan.puhan@uzh.ch). Access to the final dataset of the Swiss-SEP is possible after signing a contract with the SNC. Interested researchers, please contact the SNC directly via snc_info@ispm.unibe.ch.

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FIGURES

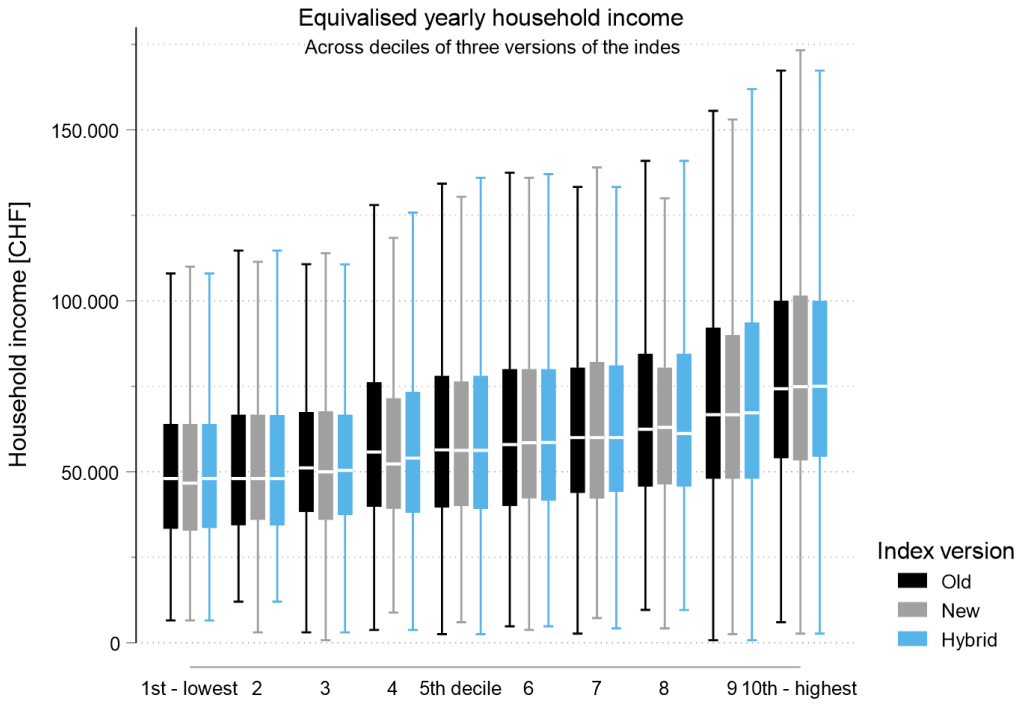

Figure 1. Box plots of the distribution of equivalised yearly household income across deciles of three indices. Data from 7,026 Swiss Household Panel participants that provided information on the income question in 2013. Boxplots exclude outliers for better visibility of the central distribution. See Supplementary Files for more details.

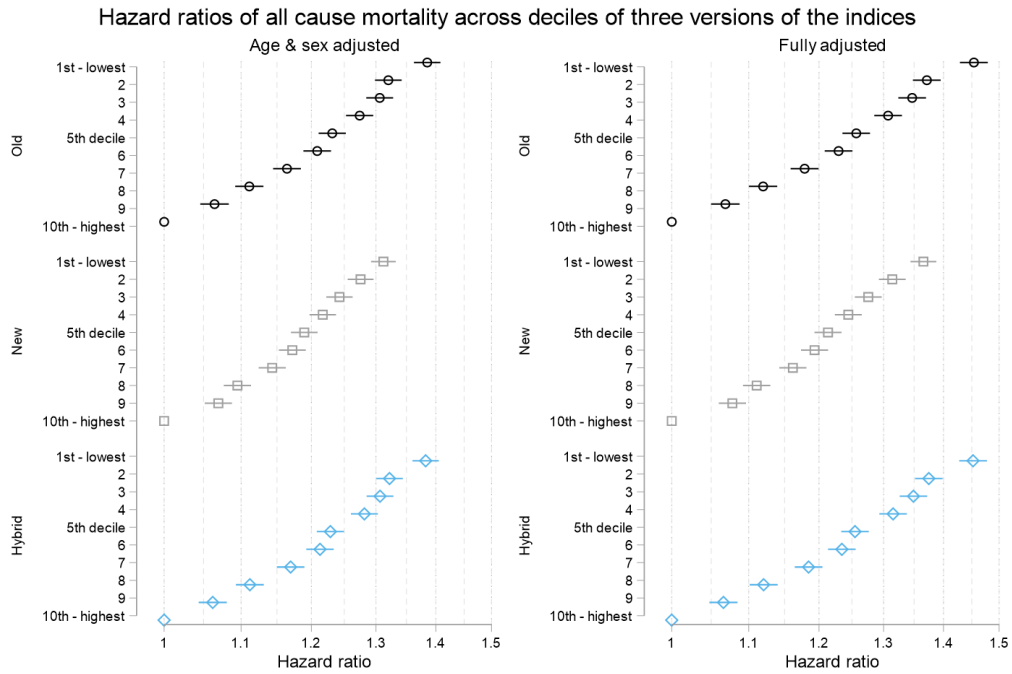

Figure 2. Hazard ratios of all-cause mortality across three versions of the Swiss-SEP indices. Analyses based on Swiss National Cohort data on 304,000 deaths between 2012 and 2018 among 5.25 million individuals aged 30 or older. Fully adjusted analyes included age, sex nationality, civil status, language region and level of urbanisation.