The Swiss-SEP neighbourhood index of socioeconomic position: Update

Radoslaw Panczak[1*], Claudia Berlin[1], Marieke Voorpostel[2], Marcel Zwahlen[1], Matthias Egger[1,3,4]

[1] Institute of Social and Preventive Medicine, University of Bern, Bern, Switzerland

[2] Swiss Centre of Expertise in the Social Sciences (FORS), Lausanne, Switzerland

[3] Population Health Sciences, Bristol Medical School, University of Bristol, UK

[4] Centre for Infectious Disease Epidemiology and Research, University of Cape Town, Cape Town, South Africa

[*]Corresponding author

Radoslaw Panczak, PhD

Institute of Social and Preventive Medicine, Mittelstrasse 43, University of Bern, 3012 Bern, Switzerland

radoslaw.panczak@ispm.unibe.ch

Abstract: 209 words

Research in context: 193 words

Body: 1,588 words

ABSTRACT

Background The Swiss neighbourhood index of socioeconomic position (Swiss-SEP) was published in 2012, based on data from the 2000 census on rent, household head education and occupation, and crowding.

Methods We created a new index based on the micro censuses 2012-2015. We used principal component analysis on neighbourhood-aggregated variables and standardised the index. We also created a hybrid version, with updated values for neighbourhoods centred on buildings constructed after 2000 and original values for remaining neighbourhoods.

Results 1.54 million neighbourhoods were included. With all three indices (old, hybrid, new), income increased from around 47,000 to 73,000 CHF from lowest to highest index decile. Analyses of mortality were based on 33.6 million years of follow-up. The adjusted hazard ratios of all-cause mortality comparing areas in the lowest decile of Swiss-SEP with areas of the highest decile were 1.39 (95% CI 1.36-1.41), 1.38 (1.36-1.41) and 1.31 (1.29-1.33) using the old, hybrid and new indices, respectively.

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

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 health-related studies in Switzerland.
- The index was based on the national census 2000 and was validated against income data from the Swiss Household Panel (SHP) collected in 1999. It was strongly associated with all-cause and cause-specific mortality in the years 2001 to 2008.
- The Swiss-SEP index may now be out of date and its usefulness for longer time periods is unclear..

What this study adds?

- We created an updated Swiss-SEP index using the yearly micro censuses that replaced the decennial house-to-house census in Switzerland since 2010.
- We also created a hybrid version of the Swiss-SEP where we updated values for neighbourhoods centred on new buildings constructed after 2000.
- We validated the old and new indexes against 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 new data on household income from SHP and recent mortality. The index will continue to be useful for epidemiological and public health research in Switzerland.

INTRODUCTION

The 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] Over 100 studies cited the index, and over 60 used it in epidemiological research on life expectancy, environmental and lifestyle exposures, assisted suicide, cancer, HIV, amyotrophic lateral sclerosis, and randomised trials [Supplementary Material 1]. Most recently, the Swiss-SEP was used to show that people living in neighbourhoods of low socioeconomic position were less likely to be tested for SARS-Cov-2 but more likely to test positive, be hospitalised, or die from COVID-19.[2]

The index is based on the persons and their residential address covered in the 2000 Census in Switzerland. The total population and where and how they live have changed since then. Therefore, the index may be out-of-date. The SEP of neighbourhoods tends to be relatively stable over time. Still, over the past two decades, Switzerland's population grew. 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 system of yearly, registry-based census surveys.[3] Full demographic data on the officially registered resident population and data on residential buildings are available. However, much of the information at the individual level used to construct the Swiss-SEP, e.g. education or occupation, or households, e.g. rent, is no longer collected for the entire population but only in approximately 200,000 surveyed residents per year. This new situation prevents an automatic update of the index using the same methodology.[1] Here we 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 [4] (SHP) and mortality data from the Swiss National Cohort (SNC).[5]

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 mortality rates by index levels. Full details of the data preparation steps, including data sources, exclusion and inclusion criteria and final size of constructed datasets are provided in 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 2012-2015. We decided against using data from 2010 and 2011, the two first micro censuses, due to data quality issues and missing information. 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 persons and their household members living in their buildings instead of a complete census necessitated enlarging the geographical size of neighbourhoods to include 50 closest households from the surveyed population.

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 define the head of the household. Instead, we used the information on the adult respondent. Additionally, the original categorisation of occupations was not available for all survey years. We, therefore, used data from the International Standard Classification of Occupations to categorise occupations.[6]

Construction and combination of indexes

We constructed the index in the same manner as previously using principal component analysis on neighbourhood aggregated indicators retaining the first component and standardising the index to a range of 0 to 100.[1] Apart from constructing the 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 values for the remaining neighbourhoods.

Validation using household panel data

We re-examined the construct validity of the index by exploring its association with income information collected in the SHP, a longitudinal study following a random sample of Swiss households.[4] We included persons from the three recruitment waves (1999, 2004, 2013) and geocoded the residences of 8,151 (97.5%) of households that completed the questionnaire in 2013. We used the same variables as in the original study.[1] Information about equivalised income was available for 7,026 (86.2%) households.

Mortality across deciles of indices

Finally, we updated all-cause and cause-specific mortality analyses as described previously,[1] based on 304,162 deaths from 2012 to 2018 among 5.25 million individuals aged 30 or older. We

used proportional hazard regression to compare mortality by deciles of the three versions of Swiss-SEP index . Analyses were performed using Stata (version 15, Stata Corporation, College Station, TX, USA), R (version 4.0.4,[7]) 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 to those 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 [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 46,670 CHF among households in the 1st Swiss-SEP decile to 73,200 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 of all-cause mortality comparing areas in the lowest decile of Swiss-SEP with areas of the highest decile were 1.39 (95% CI 1.36-1.41), 1.31 (95% CI 1.29-1.33) and 1.38 (95% CI 1.36-1.41) 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 created a new version of the Swiss-SEP index based on the micro-census data, with reduced spatial resolution, and a hybrid version that uses the original index values for buildings constructed up to 2000 and new values for buildings constructed since then. We demonstrated the feasibility of

creating a new index using a more limited amount of information than what was available in the 2000 national house-to-house census. We found a strong gradient across Swiss-SEP index deciles for all-cause and cause-specific mortality, independently of the version of the index used (old, hybrid, new).

Switzerland changed from a full census every ten years to annual surveys of about 200'000 persons. Despite the sparser data, we were able to replicate our earlier work and thus demonstrated the feasibility of updating the Swiss-SEP within the micro census system. 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 in recent years regarding high-resolution area-based SEP measures in Switzerland. Commercially available, but to our knowledge unvalidated data on purchasing power are available for municipalities.[8] 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,[9] car registrations,[10] mobile phone data,[11] or social media [12] might offer opportunities for new developments. Similarly, the availability of yearly micro censuses provide the potential for updating indices more frequently.[13]

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 practices or guidelines for developing such measures.[14]

In conclusion, all three versions of the area-based Swiss-SEP index capture SEP at a high geographical resolution. The indexes continue to offer the potential of studying associations with 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.

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. After approval of the SNC Scientific Board, a contract with the SFSO allows researchers to receive analysis files for replication of the analysis. 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.

REFERENCES

1 Panczak R, Galobardes B, Voorpostel M, *et al.* A Swiss neighbourhood index of socioeconomic position: development and association with mortality. *J Epidemiol Community Health* 2012;**66**:1129–36. doi:10.1136/jech-2011-200699

2 Riou J, Panczak R, Althaus CL, *et al.* Socioeconomic position and the COVID-19 care cascade from testing to mortality in Switzerland: a population-based analysis. *Lancet Public Health* Published Online First: 10 July 2021. doi:10.1016/S2468-2667(21)00160-2

3 Federal Statistical Office. Register system. ND.https://www.bfs.admin.ch/bfs/en/home/register/registersystem.html (accessed 17 Jun 2021).

4 Voorpostel M, Tillmann R, Kuhn U, *et al.* Swiss Household Panel User Guide (1999-2018), Wave 20. Lausanne:FORS 2020. https://forscenter.ch/wp-content/uploads/2020/05/shp_user-guide-w20.pdf

5 Bopp M, Spoerri A, Zwahlen M, *et al.* Cohort Profile: The Swiss National Cohort—a longitudinal study of 6.8 million people. *Int J Epidemiol* 2009;**38**:379–84. doi:10.1093/ije/dyn042

6 International Labour Organization. ISCO - International Standard Classification of Occupations. 2016.http://www.ilo.org/public/english/bureau/stat/isco/isco08/index.htm (accessed 3 Jan 2021).

7 R Core Team. *R: A Language and Environment for Statistical Computing*. Vienna, Austria: : R Foundation for Statistical Computing 2021. https://www.R-project.org/

8 GfK releases 2019 purchasing power for Austria and Switzerland. https://www.gfk.com/insights/gfk-releases-2019-purchasing-power-for-austria-and-switzerland (accessed 17 Jun 2021).

9 Juhn Y, Beebe T, Finnie D, *et al.* Development and initial testing of a new socioeconomic status measure based on housing data. *J Urban Health* 2011;**88**:933–44. doi:10.1007/s11524-011-9572-7

10 Lansley G. Cars and socio-economics: understanding neighbourhood variations in car characteristics from administrative data. *Reg Stud Reg Sci* 2016;**3**:264–85. doi:10.1080/21681376.2016.1177466

11 Blumenstock J, Cadamuro G, On R. Predicting poverty and wealth from mobile phone metadata. *Science* 2015;**350**:1073–6. doi:10.1126/science.aac4420

12 Quercia D, Saez D. Mining Urban Deprivation from Foursquare: Implicit Crowdsourcing of City Land Use. *IEEE Pervasive Comput* 2014;**13**:30–6. doi:10.1109/MPRV.2014.31

13 Ward AD, Trowland H, Bracewell P. The Dynamic Deprivation Index: measuring relative socio-economic deprivation in NZ on a monthly basis. *Kōtuitui N Z J Soc Sci Online* 2019;**14**:157–76. doi:10.1080/1177083X.2019.1578807

14 Allik M, Leyland A, Ichihara MYT, *et al.* Creating small-area deprivation indices: a guide for stages and options. *J Epidemiol Community Health* 2020;**74**:20–5. doi:10.1136/jech-2019-213255
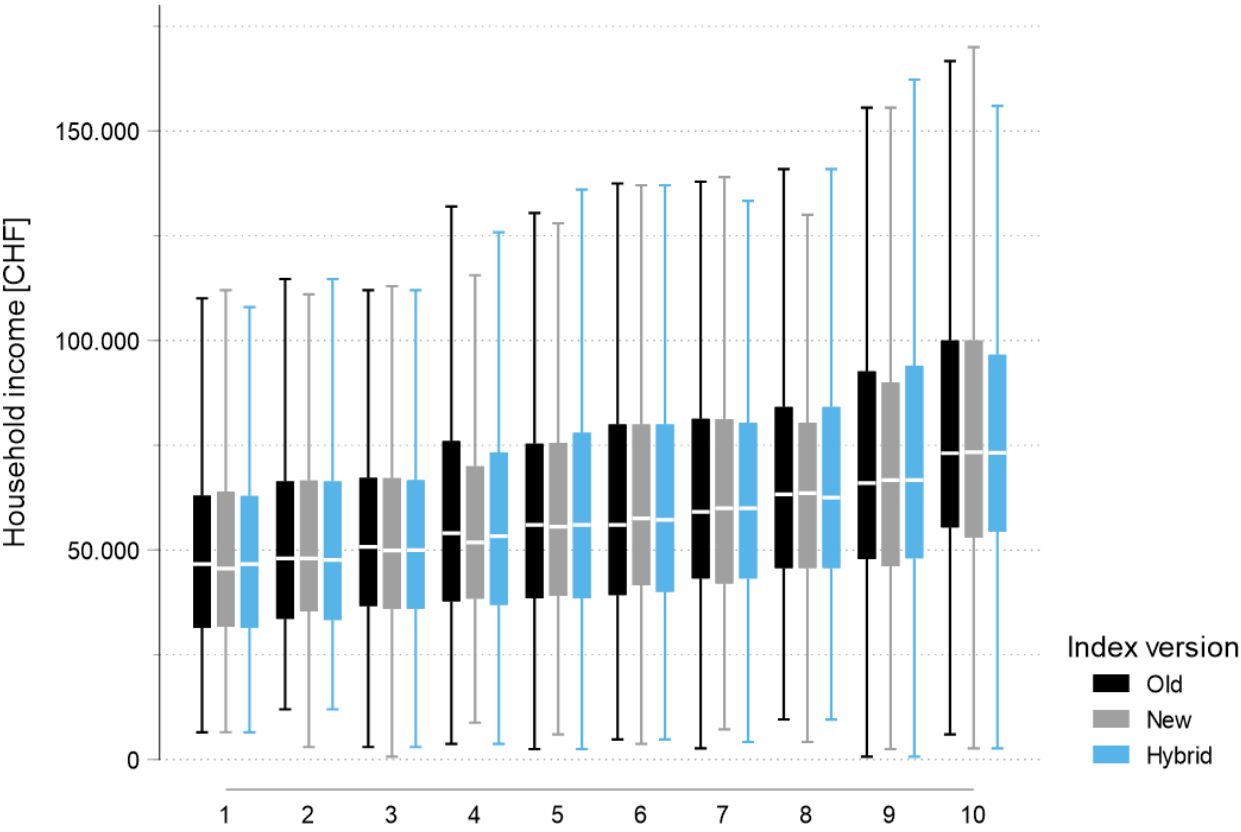
Figure 1. Box plots of the distribution of equivalised yearly household income across deciles of three indices. Data from 7,026 Swiss Household Panel participants that provided information on the income question in 2013. Boxplots exclude outliers for better visibility of the central distribution. See Supplementary Files 2 & 3 for more details.
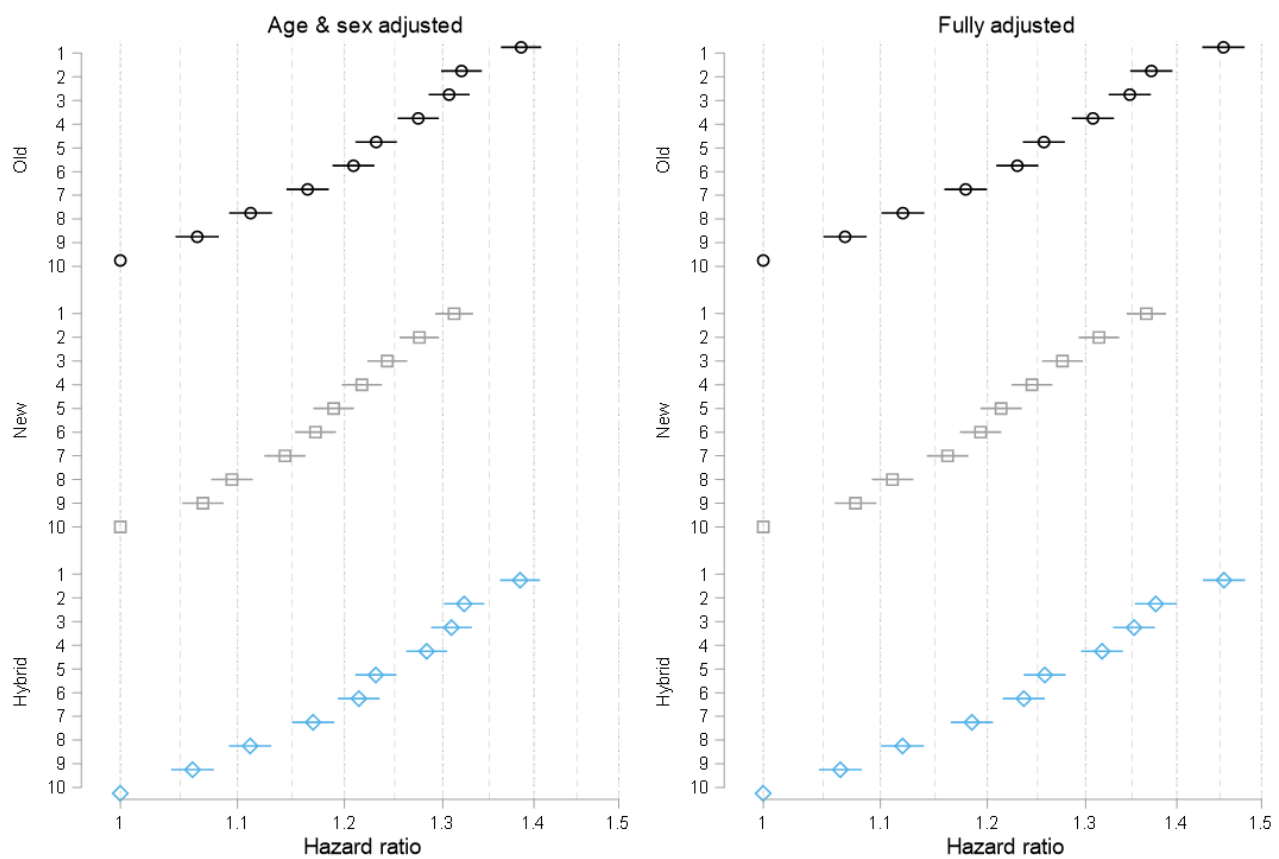
Figure 2. Hazard ratios of all-cause mortality across three versions of the Swiss-SEP indices. Analyses based on Swiss National Cohort data on 304,000 deaths between 2012 and 2018 among 5.25 million individuals aged 30 or older. Fully adjusted analyses included age, sex nationality, civil status, language region and level of urbanisation. Group "10" is the reference group for all models.