Over the last few years, a health monitoring at the federal level in Germany has been established at the Robert Koch Institute. This programme ensures regular provision of health data [1, 2]. On the occasion of the start of health monitoring, the previous operationalisation of socioeconomic status—which was based on a suggestion of Winkler and Stolzenberg (WSI Stratification Index) [3]—was subjected to critical assessment and developed further, taking into account the requirements for monitoring data [4, 5]. These requirements include the analysis of developments and trends over time, international comparability of data, and the transfer of research results in the context of politics and practical constraints. The revised method was first implemented in connection with the study German Health Update (GEDA) [4] and is, in a comparable fashion, now realised in the German Health Interview and Examination Survey for Adults (“Studie zur Gesundheit Erwachsener in Deutschland”, DEGS1).

The DEGS1 study is based on the German National Health Interview and Examination Survey 1998 (GNHIES98), an interview-based survey with a medical examination component. The results of this survey have already been widely adopted at both the national and international level. On the basis of this study, socio-economic health differences have also been comprehensively analysed. The results show that for the findings of the GNHIES98 there were pronounced socioeconomic differences in terms of health behaviour, the existence of health risks and health impairments, disease burden and the use of medical services in Germany in the year 1998 [6, 7, 8]. In addition, further studies incorporating the GNHIES98 showed that these differences are in the middle of the range compared to other European states and that they have widened over time in some areas [9, 10]. Using the data of DEGS1, the previous analyses using the GNHIES98 can be updated. This includes the possibility to analyse time trends regarding health inequalities, if the changes in the measurement of the SES are correctly taken into account.

In this study, the operationalisation of socioeconomic status for DEGS1 is presented. We also present comparative values between the old and new operationalisation of the SES for GNHIES98. An allocation table for the individual dimensions of the SES enables reproduction of the SES index using other data records, provided that all information required for index formation are available.

Data and methods

The German Health Interview and Examination Survey for Adults (DEGS1) forms an integral part of the health monitoring of the Robert Koch Institute (RKI). The concept and design of DEGS1 are described in detail elsewhere [1, 2, 11, 12, 13]. The first data collection phase (DEGS1) was carried out between 2008 and 2011 and comprised interviews, examinations and tests [14, 15]. The target group was the population living in Germany aged between 18 and 79. DEGS1 incorporates a mixed design which enables both cross and longitudinal section analysis. As part of the study, residents’ registration office samples were complemented by participants of the German National Health Interview and Examination Survey 1998 (GNHIES98). In total, 8,152 persons participated, including 4,193 first-time participants (response 42%) and 3,959 former participants of the GNHIES98 (response 62%). There were 7,238 persons who visited one of the 180 examination centres, whereas 914 were only interviewed. The net sample [13] enables representative cross analyses and trend statements for the age group from 18–79 years compared to the GNHIES98 (n=7,988, out of whom 7,116 in examination centres). The data of repeat participants can be used for longitudinal section analysis. The cross and trend analyses are carried out with a weighting factor which corrects deviations of the sample from the population structure (as at 31 Dec 2010) in terms of age, sex, region and nationality as well as municipality type and education [13]. For the examination part, a special weighting factor was designed. In calculating the weighting factor for former participants in GNHIES98, the probability of a person participating again was taken into account, based on a logistic model. For the purpose of conducting trend analyses, the data of the German National Health Interview and Examination Survey 1998 are age-adjusted for the population level as at 31 Dec 2010. A non-responder analysis and a comparison of individually determined indicators with official statistical data indicate a high degree of representativeness of the sample in the resident population of Germany [13].
Tab. 1 Calculation basis for the index of the socioeconomic status (SES Index) in DEGS1 (2012) For information on how points are awarded, cf. Lampert et al. [4]

<table>
<thead>
<tr>
<th>Points</th>
<th>School and professional qualification</th>
<th>Professional status of respondents or of the head of household</th>
<th>Net equivalent income</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0–1.9</td>
<td>No school and no professional qualification (1a: 1.0) Certificate of Primary Education (&quot;Hauptschulabschluss&quot;) and no vocational qualification (1b: 1.7)</td>
<td>Farmer: 10 ha and more (1.0) Farmer, no details provided (1.0) Farmer: Under 10 ha (1.1) Unskilled workers (1.3) Semi-skilled workers (1.8) Workers, no details provided (1.9)</td>
<td>≤491 € (1.0) 492–683 € (1.5)</td>
</tr>
<tr>
<td>2.0–2.9</td>
<td>Certificate of Secondary Education (&quot;Mittlerer Schulabschluss&quot;, &quot;Realschulabschluss&quot;) or POS certificate and no vocational qualification (2b: 2.8)</td>
<td>Foreman, group leader (2.0) Skilled or specialist tradesmen (2.1) Master, site foreman, overseer, (2.4) Employees with executing responsibilities (2.4) Others, no details provided (2.9) Civil servants in Lower Service (2.9)</td>
<td>684–815 € (2.0) 816–921 € (2.5)</td>
</tr>
<tr>
<td>3.0–3.9</td>
<td>No school or primary certificate and training/apprenticeship/vocational school (1c: 3.0) Certificate of Secondary Education, POS and training/apprenticeship/vocational school (2a: 3.6) Technical college qualification (&quot;Fachhochschulreife&quot;), University Entrance Qualification (&quot;Abitur&quot;), EOS and no vocational qualification (2c-voc: 3.7)</td>
<td>Self-employed: no staff (3.5) Employees doing qualified work (3.6) Self-employed: 1–4 staff (3.6) Employees, no details given (3.7) Self-employed in trading, business etc. (3.9)</td>
<td>922–1082 € (3.0) 1083–1188 € (3.5)</td>
</tr>
<tr>
<td>4.0–4.9</td>
<td>Technical college qualification, University Entrance Qualification, EOS and training/apprenticeship/vocational school (2c-voc: 4.8)</td>
<td>Self-employed or freelancer, no details given (4.0) Civil servants in Intermediate Service (4.1) Employees in a position of responsibility (4.2) Self-employed: 5 or more employees (4.2) Self-employed: PGH member (4.2) Employees with extensive leadership responsibilities (4.7)</td>
<td>1189–1310 € (4.0) 1311–1417 € (4.5)</td>
</tr>
<tr>
<td>5.0–5.9</td>
<td>Category not taken</td>
<td>Civil servants, no details given (5.0) Civil servants in Higher Service (5.2) Freelancers: no employees (5.8)</td>
<td>1418–1619 € (5.0) 1620–1833 € (5.5)</td>
</tr>
<tr>
<td>6.0–7.0</td>
<td>Technical college qualification, University Entrance Qualification, EOS and Bachelor, Technical College Diploma (3a: 6.1) Technical college qualification, University Entrance Qualification, EOS and Master/Magister/Diploma, PhD (3b: 7.0)</td>
<td>Freelance academics (6.2) Civil servants in Highest Service (6.4) Freelancers: 1–4 employees (6.8) Freelancers: 5 or more employees (7.0)</td>
<td>1834–2125 € (6.0) 2126–2692 € (6.5) ≥2693 € (7.0)</td>
</tr>
</tbody>
</table>

POS Polytechnic Secondary School ("Polytechnische Oberschule"), EOS Extended Secondary School ("Erweiterte Oberschule"), PGH Craftmen’s Production Cooperatives ("Produktionsgenossenschaften des Handwerks").

**Operationalisation of the index components**

In revising the operationalisation of the socioeconomic status, the basic concept of the previously used WSI Stratification Index was retained [3]. The revised SES index is also based on the three status dimensions education, occupation and income. They have equal weight in the resulting score. The dimension education is operationalised as an individual characteristic on the basis of the academic and professional qualification of respondents, whereas the dimensions occupation and income are considered as household characteristics. In each dimension, a minimum of one and a maximum of sev-

German National Health Interview and Examination Survey 1998 (GNHIES98) is the predecessor study of DEGS1, and it was carried out between October 1997 and March 1999 [16, 17]. As part of the GNHIES98, 7,124 persons aged between 18 and 79 were interviewed on health-relevant topics and subjected to a medical examination. The response rate amounted to 61%. It was possible to replicate the revised SES index using the GNHIES98 by incorporating the methodology described below. This enabled a comparison with the originally used WSI Stratification Index.

For the operationalisation of the socioeconomic status, information on the age and sex of respondents, on their academic and professional training, their occupational position and activity, their income status, household net income, household composition and their place of residence was taken into account. The statistical analyses are conducted with Stata SE 12.1 and replicated with SPSS Statistics 20. For this purpose, a standard weighting factor from DEGS1 supplied by the data holder was used. All analyses take participants who did not complete the examination part in account.
en points are awarded, with in-between values also being possible. The differences in point values reflect differences with regard to external criteria. This means that metric scaling of the individual dimensions can be assumed. The categories and corresponding point values of the index are presented in Tab. 1.

For classifying educational qualifications, groups based on the international classification Comparative Analyses of Social Mobility in Industrial Nations (CASMIN) were used [18]. The classification makes a distinction between nine educational groups which are the result of combinations of academic and professional qualifications. The point values standardised for the range of 1–7 reflect the average salaries earned in Germany by persons with the same qualifications.

Professional status was operationalised as a household characteristic. For this purpose, the professional status of respondents and the professional status of the principal earner in the household were compared. The higher value was then assigned to the household. The International Socio-Economic-Index of Occupational Status (ISEI) according to Ganzeboom et al. [19] was used as the criterion for assigning point values. The ISEI Index refers to occupational activities which are coded in accordance with the professional classification ISCO-88. The point values with a variation range from 1–7 were generated on the basis of data from the study GEDA 2009 [4].

In terms of income, the need-weighted household net income (net equivalent income) was, in line with the specifications on poverty and affluence reporting of the Federal Government and the European recommendations for reporting on social cohesion in Europe, used as the indicator [20]. Missing values for household net income were imputed by means of a regression model [4]. In addition, the information provided by respondents on their age, education, and professional status as well as regional statistical data of the Federal Statistical Office on the medium household net income for the residential area of respondents were used. To determine the point values, 13 equally large income groups (quantiles) were created statistically. The interval from one income group to the next amounts to a point value of 0.5 points, starting by a value of 1.0 for the first group.

Calculation of the multidimensional SES index

The revised SES Index is calculated as a total points score on the basis of the point values assigned in the individual dimensions of education, occupation and income. Since three subscales with the same weight and range are included in the calculation, the SES Index can have values between 3.0 and 21.0. The SES Index can be included in analyses as a metric variable. Alternatively, a categorisation into several status groups can be performed. For this purpose, a distribution-based demarcation into five equally strong groups (quintiles) is suggested, with the three middle groups (2nd to 4th quintile) combined into a large “medium SES” group. This three-stage scale (low, medium and high SES) enables a comparison—measured by the accumulation of educational qualifications, professional status and income—between the bottom and top 20% of the population with a broadly defined centre which comprises 60% of the population. These categories, limit values, and the associated proportion of respondents in DEGS1 are represented in Tab. 2. The proportion of participants with missing values is 3.4%. For participants who
completed both the examination and the interview part it is only 2.6%.

In Table 3, the corresponding proportions for 18–29, 30–44, 45–64 and 65 year olds and older persons are presented, differentiated by sex. According to this table, slightly more men than women have a high socioeconomic status. In addition, the proportion of men and women with a high status is higher in the middle age groups than in the younger and older age groups. The age-specific distribution of socioeconomic status corresponds to values published for the GEDA study 2009 [4].

Like the previously used WSI Stratification Index [3], the SES Index shows high concordance with other dimensions of socioeconomic status. Based on the data of GHNIES98, Table 4 presents the correlation between the SES and WSI score, the individual dimensions of SES and other values of socioeconomic status for full-time respondents established in the social structure analysis. A comparison on the basis of DEGS1 was not possible at the time this manuscript was drafted.

**Discussion**

Socioeconomic status constitutes a central analysis category of epidemiological research and health reporting. Results on status-specific differences in health condition, health behaviour and in health care highlight social problems and indicate target groups for interventions in health, social and political policy at the same time. As a result, the socioeconomic status is taken into account in many epidemiological studies or is even the focus of the research. A comparison of the results across different studies requires socioeconomic status to be measured in a standardised way. An important reference for Germany is the suggestion by Winkler and Stolzenberg [3]. The suggestion was developed in the course of the DHP study (1984–1991) and also provided the basis for the recommendations of the German Association of Epidemiology for measuring sociodemographic characteristics in epidemiological studies [23]. This multidimensional aggregated index was also used in the German National Health Interview and Examination Survey 1998 and the telephone health interviews in 2003 and 2006 which were all conducted by the RKI. The calculation basis was adjusted for this health survey in order to accommodate income inflation, increased educational participation and structural occupational changes [5].

The establishment of the federal health monitoring at the RKI was taken as an opportunity to test and improve the index formation process. The most important differences to the previous procedure are the operationalisation and categorisation of the status-forming characteristics education, professional status and income as well as the demarcation of status groups on the basis of the index calculated as a total points score. In contrast to the suggestion by Winkler and Stolzenberg [3] the initial variables education, professional status and income are not converted into ordinal but rather into metric scales. This results in a differentiated gradation and in advantages in the calculation of the SES Index and the distribution-based demarcation of the status groups. In addition, in categorising the variables and assigning point values to the categories, internationally tried and tested instruments and criteria were used. This has the ad-
vantage that even when the scores for the individual dimensions are used, reliable results can be achieved which are comparable to other studies.

Another difference to the WSI Stratification Index is that the index formation was based on a distribution-based demarcation of the status groups. In this way, five equally large status groups can be distinguished, each of which comprises 20% of the population. The demarcation suggested over and above that, i.e. for the 1st, 2nd to 4th and 5th quintile of the index values (status groups with low, medium and high SES), supports statements on the difference with regard to the health indicators considered in each case between the 20% of the population under investigation which are situated at the bottom and top end of the status hierarchy, the middle being more broadly defined. One advantage of the distribution-based demarcation of the status groups becomes clear in the analysis of developments and trends over time. Thus it is possible, using the SES Index, to analyse the extent of relative health inequalities between two points in time, even if income distribution, participation in education of the population or the occupational hierarchy have changed since the last analysis.

A multidimensional SES index is a suitable instrument for describing the extent and development of health inequalities, for example due to the simpler way of communicating its results in contrast to a single indicator approach (e.g. income, education). Equally, the SES Index can be used in epidemiological analyses, for example for determining risk profiles for certain chronic diseases. This applies to both the analyses of independent influencing factors and for confounder control. However, it must be taken into account that the informative value of results obtained by means of a multidimensional SES Index is subject to limitations. This becomes especially clear in situations where detailed explanations of interrelations for the observed health inequality are sought or where the concrete target groups are to be identified for interventions. Analyses with the individual indicators education, professional status and income could be more informative in this context, since they make it easier to draw conclusions about the significance of health-relevant attitudes and behaviours, occupation-related stress factors and resources or material living conditions [23, 24].

**References**


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**Bundesgesundheitsblatt - Gesundheitsforschung - Gesundheitsschutz 5/6, 2013** 5