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The Danish National Health Survey. Study design, response rate and respondent characteristics in 2010, 2013 and 2017

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Abstract

Aim: To describe the study design, including descriptive statistics on changes in response rates, characteristics associated with response and response mode distribution, in the Danish National Health Survey in 2010, 2013 and 2017.

Methods: Each survey was based on five regional stratified random samples and one national random sample drawn from the Danish Civil Registration System. The subsamples were mutually exclusive. Around 300.000 individuals (16 years or older) were invited to participate in each survey using a mixed mode approach (paper/web). A questionnaire with minimum 52 questions was used in all subsamples. In 2010 and 2013, invitations were sent by regular postal service, whereas a secure electronical mail service was used to invite the majority (around 90%) in 2017. Weights accounted for survey design and non-response.

Results: Participation decreased from 59.5% in 2010 to 54.0% in 2013 after which it increased to 58.7% in 2017. The proportion answering the web-questionnaire, increased from 31.0% to 77.4% between 2013 and 2017 and varied from 73.8% to 79.7% between the subsamples in 2017. Overall, the response rate was low among young men and old women, and among individuals who were unmarried, had low sociodemographic status, were from ethnic minority backgrounds, or were living in the eastern part of Denmark.

Conclusions: Survey mode, response mode distribution as well as response rate have changed over time. Weights to handle non-response can be applied to accommodate possible problems in generalizing the results. However, efforts should continuously be made to ensure that response is missing at random.

Keywords: Cross-sectional studies, Study design, Data collection, Health surveys, Health surveillance

Background

Public health surveillance systems are crucial in health care planning and policy development (1). To obtain such surveillance systems, health surveys constitute an essential component. Even in countries where official health registers are available, information collected in health surveys typically covers other topics, e.g. indicators of self-rated physical and mental health, health behaviour and social relations. Hence, data from health surveys provide a unique opportunity to generate a very diverse and detailed picture of a population's health status and monitor the health status over time. Moreover, register data usually only provide information on medical conditions, for which contact with a hospital was necessary (e.g. stroke, and cancer). This means that data on conditions that generally require less treatment in hospital, albeit more common in the daily life of the general population, are not included in registers (e.g. allergy, headache and mental illness) (1). Thus, such information can only be revealed by means of surveys. Moreover, in many countries, sufficient registers are not available, and, accordingly, surveys are the only source of data on the population's health. However, a tendency towards declining response rates in surveys has been observed in several countries (2-4). If non-respondents deviate markedly from respondents, the representativeness and generalizability of the survey data are compromised (3). Other potential limitations of survey data validity are the risk of recall bias and social desirability bias (5).

In 2010, 2013 and 2017 the five Danish regions, the National Board of Health and the National Institute of Public Health at the University of Southern Denmark (NIPH) conducted large national representative population-based surveys entitled 'The Danish National Health Survey'. The survey is based on self-administered questionnaires and the overall aim is to monitor the status and trends in physical and mental health, health behaviour and morbidity in the adult (≥ 16 years) Danish population. The surveys are a result of an extensive national co-operation across sectors, which make the survey useful in multiple applications e.g. health surveillance, planning and prioritizing public health initiatives and research.

The aim of the present paper is to describe the study design, including descriptive statistics on changes in response rates, characteristics associated with response and response mode distributions of the Danish National Health Surveys, which were carried out in 2010, 2013, and 2017.

Methods

Sample design

The Danish National Health Survey is conducted every three to four years from the end of January / beginning of February to the beginning of May. The survey is based on six mutually exclusive random subsamples among the adult (≥ 16 years) Danish population; one in each of the five Danish administrative regions and one national sample. Figure 1 shows the number of municipalities and the size of the population aged 16 years or older in each region in 2017. NIPH is responsible for the national sample and the five regions are responsible for the sample in their respective region, e.g. development of questionnaire, data collection and reporting of data. Center for Clinical Research and Prevention, Bispebjerg and Frederiksberg Hospital in the Capital Region of Denmark is responsible for the sample in the Capital Region of Denmark, department for Intersectoral cooperation in the Region of Southern Denmark is responsible for the sample in the Region of Southern Denmark, department of Continuity of care and economy in the North Denmark Region is responsible for the sample in the North Denmark Region, department for Data & Development Support in Region Zealand is responsible for the sample in Region Zealand, and DEFACTUM in the Central Denmark Region is responsible for the sample in the Central Denmark Region. Each regional sample consists of random samples of individuals from each of the municipalities in the region. It was decided that the regional samples should have a minimum sample size of 2,000 individuals in each municipality or half of the adult population in municipalities with less than 4,000 citizens eligible for study participation. However, both the regions and NIPH could choose to increase their respective random samples as long as the additional sample members were chosen randomly. The samples were drawn from the adult population in Denmark (including institutionalized persons) using the Danish Civil Registration System which contain basic information on all persons who have been or are currently residing in Denmark (6). The Danish Health Data Authority was responsible for drawing the sample based on specification describing the sampling procedure. The total sample consisted of 298,550 individuals in 2010, 300,450 individuals in 2013 and 312,349 individuals in 2017. This correspond to approximately 6% of the adult Danish population. Supplementary Table 1 lists the number of invited individuals in the six subsamples in the three surveys. The national sample consisted of a follow-up sample of individuals invited to participate in earlier surveys (approximately 4,500 individuals) and a cross-sectional sample ensuring a nationally representative sample size of 25,000 individuals (approximately 20,500 individuals). The

sample sizes were increased in most subsamples, mainly from 2013 to 2017, to compensate the declining response rate and to increase the power in subgroup analysis. The sample design of the survey in 2010 is described elsewhere (7).

Survey mode

In all surveys, a concurrent mixed-mode approach was used to collect the data, allowing the invited individuals to complete either a web-questionnaire or to fill out a paper questionnaire (mixed-mode response options). In the Central Denmark Region in 2010, however, it was only possible to complete a paper questionnaire. Initially, an invitation to participate and an introduction letter briefly describing the purpose and content of the survey was sent to all invited individuals. It was emphasized that participation was voluntary. For each individual, the introduction letter contained a unique username and password that enabled access to the web-questionnaire. However, the specific wording of the introduction letter varied across the subsamples. In 2010 and 2013, the introduction letters, a paper questionnaire and a response envelope were sent by regular postal service to all invited. In 2017, a secure electronic mail service (Digital Post) was used to invite the majority (around 90%). Individuals invited by Digital Post received an introduction letter but no paper questionnaire. Individuals who were not registered to use Digital Post (around 10%), were sent an introduction letter by regular postal service, inviting them to complete a web-questionnaire or the enclosed paper questionnaire (mixed-mode contact). This group of individuals were primarily elderly. Thus, the sample in 2017 comprised two subsamples based on mode of initial contact 1) individuals invited initially by Digital Post and 2) individuals invited by regular postal service only.

Reminders were sent to all invited individuals who had not yet returned or submitted the questionnaire, excluding those who had actively indicated that they did not want to participate. However, the number of reminders varied across the three surveys as well as within the two subsamples in 2017 (Figure 2). In 2010, 2013 and in the subsample invited by regular postal service in 2017, a minimum of two reminders were sent by regular postal service. In the introduction letter and the second reminder, a paper questionnaire and a pre-paid return envelope were enclosed. In 2017, a minimum of four reminders were sent to individuals in the Digital Post subsample. If the web-questionnaire was not completed after 1 week, an electronic reminder was sent to non-responding individuals. As it was not known whether non-response was caused by not seeing the Digital Post or not wanting to respond, non-respondents in the Digital Post subsample received an enquiry including a paper questionnaire and a pre-paid return

envelope by regular postal service after another 3 weeks. The remaining two reminders in the Digital Post subsample were sent by regular postal service, the last one with an enclosed paper questionnaire and a pre-paid return envelope. In addition to the above-mentioned standardized reminder strategy, additional reminder strategies were applied in some subsamples (Figure 2). This was most pronounced in 2010 where the North Denmark Region and the Central Denmark Region contacted non-responders by phone and the Region of Southern Denmark and NIPH contacted non-responders by SMS. In 2017, only the Central Denmark Region used additional reminders (by phone).

Questionnaire

A standard questionnaire including a minimum of 52 questions was mandatory to use in all six samples in all three surveys. The questionnaire included questions on e.g. socio-demography, quality of life, longstanding illness, health behaviour, contact with health services and social relations. Validated questionnaire scales such as the 12-Item Short-Form Health Survey version 2 (SF-12 v2), Perceived Stress Scale (PSS) and a screening tool for alcohol abuse (the CAGE-C test) were included (8-12). The detailed content of the standard questionnaire is listed in Table 1. In addition to the standard questions, it was possible to add to the questionnaire questions of specific interest. Hence, the number of questions (which could include multiple items) and length of the questionnaire varied between the six samples and over time (Supplementary Table 2). In some subsamples, a specific questionnaire was developed for the younger part of the sample population, which included as a minimum the standard questions. In each survey, the detail content of the standard questionnaire and common rules for layout were decided. However, differences were observed in the layout of the paper questionnaire and in the technical software used to develop the web-questionnaire.

Register data

The Danish Civil Registration System (6) was used to retrieve information on sex, age and marital status. Information on the highest completed education was extracted from the Danish education register (13) and was categorized as less than 10 years, 10–12 years, and more than 12 years of education. Labour market affiliation was obtained from the Employment Classification Module (AKM), which contains information on economic and employment conditions for each person's most important employment activity, i.e. their most important source of income, throughout the year

(14). Information on educational level and labour market affiliation was only obtained for individuals age 25 years or older as very few had completed their education and established labour market affiliation before age 25.

Weighting

Weights were constructed by means of the generalised regression estimator. Our implementation of this method relies on auxiliary information from Statistics Denmark's registers taking into account different sampling probabilities and differential non-response (15, 16). The personal identification numbers of both respondents and non-respondents were linked to official registers using the Danish Civil Registration System. The information used to compute the weight included e.g. sex, age, municipality of residence, highest completed level of education, ethnic background, hospitalization and occupational status. However, small variations exist in the information used to compute the weights in the different surveys.

Statistical methods

Descriptive statistics were used to present the results and to describe the characteristics of the samples. All analysis was conducted using SAS version 9.4.

Results

Overall, the questionnaire was fully or partially completed by 117,639 (59.5%), 162,283 (54.0%), and 183,372 (58.7%) respondents in 2010, 2013 and 2017, respectively (Table 2). A response was defined as answering at least three questions (sex, age and any other question). In each survey, the response rate was lower among men (2010: 55.5%; 2013: 50.4%; 2017: 54.8%) than among women (2010: 63.4%; 2013: 57.5%; 2017: 62.6%) and particularly low (less than 45%) among men aged 16–34 years and women aged 85 or older. Moreover, there was a low response rate among unmarried individuals, among individuals with less than 10 years of education, individuals who were unemployed or outside the labour market and among individuals with a non-Danish ethnic background.

The response rate also varied between the subsamples over time. In the national sample, the response rate declined from 2010 to 2017. In the Capital Region of Denmark, Region Zealand, Central Denmark Region and North Denmark Region the response rate declined from 2010 to 2013 whereafter the response rate increased from 2013 to 2017. In the Region of Southern Denmark, the response rate remained stable from 2010 to 2013 whereafter the

response rate increased from 2013 to 2017. In all surveys, the regional subsamples in the western part of Denmark (Region of Southern Denmark, Central Denmark Region and North Denmark Region) tended to have higher response rates than the regional subsamples in the eastern part (Capital Region of Denmark and Region Zealand). These differences were also observed in the national sample.

Table 3 displays the proportion responding by web among the six subsamples in 2017 and in total for 2013. There was overall, and for all age-, sex-, marital, socio-economic and ethnic groups, a clear tendency for respondents to be more likely to complete the web-questionnaire in 2017 compared to 2013. Thus, the overall proportion of respondents completing the web-questionnaire increased from 31.0% in 2013 to 77.4% in 2017. Both the relative and absolute increase was more modest among younger men and more pronounced among elderly women, divorced or widowed persons. The increase was very similar in ethnic groups. A particularly pronounced relative increase was observed among men aged 75 years or older (from 9.8% in 2013 to 55.6% in 2017), women aged 75 years or older (from 4.7% in 2013 to 41.3% in 2017) and widowed persons (from 10.6% in 2013 to 52.7% in 2017). Differences were also observed across the subsamples. In 2017 the proportion completing the web-questionnaire varied from 73.8% in the national subsample to 79.7% in the Central Denmark Region subsample.

Discussion

The Danish National Health Survey is a result of extensive national cooperation across sectors, which makes the surveys useful in multiple fields of applications. The national coordination of questionnaire content, methodology and timing of the survey makes it possible for municipalities to compare their results with national and regional averages and with municipalities across regions. In addition, the local ownership and results at the local level will probably make health politics more data-driven..

Further, data from the surveys constitutes a unique research database. In this respect, the major strengths are the large number of respondents, the setting in a general population and the diversity of questionnaire content. However, as the survey is only based on questionnaires and not include any objective measures it is only possible to obtain prevalence of self-reported illness but not objectively diagnosed disease and conditions.

Declining response rate has been observed in several countries (2, 3, 17, 18). In the present study, the response rate declined between 2010 (59.5%) and 2013 (54.0%) whereafter the response rate increased to 58.7% in 2017. A possible explanation for the absence of a further decline in 2017, is the additional number of reminders (four compared to two) sent to the Digital Post subsample. Previous studies have shown a substantial increase in response when multiple reminders were applied (19-21). Another explanation is the mixed-mode contact approach applied in the 2017 survey. This approach implied that all selected individuals registered to use Digital Post were initially invited to complete only a web-questionnaire. In Denmark, Digital Post is typically used by public authorities, e.g. health authorities, and private companies such as banks and insurance companies to deliver a message to a specific citizen. Digital Post is sent with permission and encrypted, which means that the digital security is very high and higher than for mails sent by regular postal service and e-mails. Because spam is a large and ubiquitous part of the Internet, successful administration of web-surveys is essential in order to make the respondents not treat legitimate survey contact e-mails as spam (22). The use of Digital Post in the survey in 2017 may therefore have resolved this issue, and it seems likely that respondents registered to use Digital Post may have perceived the introduction letter and thus the survey itself as more serious than in earlier surveys where the introduction letters were sent by regular postal service (4). Moreover, as public authorities use Digital Post to inform citizens about e.g. medical examinations, it is possible that respondents who are regularly contacted by such authorities, and among those citizens who are typically underrepresented in health surveys (e.g. individuals with chronic disease), are more likely to receive, read and react to the survey invitation than if contacted by regular postal service. This is supported by studies showing the non-responding individuals have higher mortality and morbidity compared to respondents (23, 24). Further, the observed increase use of the web- survey among older individuals might in part be a cohort effect and in part due to greater technical awareness and access over time. Last, an explanation might be that the use of the same mode of contact as the desired mode of completion increased response rates, i.e. it is more likely that somebody will take part in a web- survey if they are approached online.

Mindell et al. (18) have compared response rates across surveys in seven European countries. Initial participation rates aged 35-64 were 45% in the Netherlands, 54% in Germany, 55% in Italy, and 65% in Finland. Hence, the overall response rate observed in the present study is comparable to response rates obtained in similar countries. However, a drawback with survey data is the possible restrictions in generalizing data from surveys to the target population if non-respondents are not missing at random (3, 25). The observed low response rate among young

individuals, especially among men aged 16–24 years and women aged 85 years or older, is a matter of concern in the present study. However, the calculation of calibrated weights makes it possible to statistically adjust for at least some of the differential non-response when analysing the survey data. The observed non-response is in line with findings from other studies which supports the notion that some population groups are difficult to recruit to survey participation (3, 17, 18, 26, 27). For example, we found that individuals from lower socio-demographic groups are more often non-respondents than individuals from higher socio-demographic groups. Also, people in younger age groups, non-married (compared to married) and individuals with another ethnic background than Danish were more likely to be non-respondents (even when controlling for age and gender). The questionnaire was only available in Danish, which may explain the low response rate observed among ethnic minorities. Finally, the response rate was low in the Capital Region of Denmark sample, which is in keeping with other studies that have also reported lower non-response rates in urbanized areas (3, 17, 18, 26, 27).

Both the overall response rate and the proportion answering the web-questionnaire varied to some degree between the six subsamples. This is apart from abovementioned differences in reminders probably due to differences in sociodemographic composition across the samples, the introduction letter, the technical software used and layout of the web-questionnaire as these are known to influence the response rate (20, 28).

Last, the mixed-mode design of the survey can lead to internal measurement error due to mode effect. Consequently, it is important to consider the potential impact of mode on the data collected (22, 28-30). Studies assessing the effect of implementing mixed-mode designs as part of public health surveys conclude that self-administered paper and web-questionnaires can be combined effectively (22, 28, 31). The benefits include a cheaper and faster data collection and a possibility from the mixed mode approach to enhance representativeness and increase responsiveness by making the study more accessible to a larger group of respondents. For respondents, the benefits include convenience and ease of use. Hence, the change in mode over time towards more responses from web-based questionnaire is likely to explain that response rate did not decline further from 2013 to 2017. It is also likely that it has enhanced the representativeness.

Conclusion

The Danish National Health Surveys are a result of extensive national cooperation across sectors, which makes it useful in multiple applications, e.g. health surveillance, planning and prioritizing public health initiatives and research. The response rate declined between 2010 and 2013 whereafter the response rate increased in 2017. The data mode distribution between 2010 and 2017 showed an marked increase in the proportion completing the web-questionnaires compared to the paper questionnaires. In combination with the use of Digital Post and additional reminders, this may have contributed to the increased response rate from 2013 to 2017. When feasible, future surveys are encouraged to consider the increasing preference for completing web-questionnaires in surveys in order to increase or maintain the response rate. Non-responders may pose problems in generalizing data. Even though weighting to some degree can accommodate this, efforts should continuously be made to ensure that non-response is missing at random in future surveys. Possible actions might be use of targeted cover letters or other targeted survey features aimed at non-responding groups.

List of abbreviations

NIPH: National Institute of Public health, University of Southern Denmark

SF-12 v2: 12-Item Short-Form Health Survey version 2

PSS: Perceived Stress Scale

Declarations

Ethics approval and consent to participate: In the letter of introduction for each survey it was emphasised that participation was voluntary. Thus, upon answering the questionnaire the respondent gave written consent to participate in the survey. The three surveys are approved by the Danish Data Protection Agency with id number

15/95170, 15/95274 and 16/94616 respectively. According to Danish law, an ethics review is not required. The study complies with the declaration of Helsinki.

Consent for publication: Not applicable.

Availability of data and materials: The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Competing interests: The authors declare that they have no competing interests.

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Authors' contributions: AIC and AHA wrote the first draft of the manuscript. AIC and MD did the analyses. AIC, CJL, PLK, SBJ, AW, KF, MD, AHA all critically reviewed and approved the final version of the manuscript.

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Figure 1. Map of Denmark with the number of municipalities and the size of the population (16 years or older) in each region. 2017. ©Colourbox.dk / picoStudio

Figure 2. Time of distribution and type of enquiries in the six subsamples in 2010, 2013 and 2017. W# indicates week number after submission of the initial invitation.

Table 1. Content of the standard questionnaire in The Danish National Health Survey

Table 2. Response rate in The Danish National Health Survey according to sex, age, marital status, ethnic background and sub-sample among all invited in the three surveys 2010, 2013 and 2017. Percentages

Table 3. Data mode distribution (web) in The Danish National Health Survey according to sex, age, marital status, and ethnic background among the six subsamples in 2017 and total for 2013. Percentage of respondents who filled in the web-questionnaire.

Supplementary Table 1. Number of individuals in the six subsamples in The Danish National Health Survey 2010, 2013 and 2017

Supplementary Table 2. Number of questions and pages in the paper-based questionnaire used in the six samples in The Danish National Health Survey 2010, 2013 and 2017