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LIFESTYLE AND CHRONIC DISEASES

BELGIAN HEALTH EXAMINATION SURVEY 2018

BELHES 2018

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COMMISSIONER

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SUMMARY

In 2018 and 2019, a national health examination survey was organised for the first time in Belgium. This survey was carried out among 1184 people who had already participated in the Belgian health interview survey 2018. A national health survey has an important added value for the following reasons:

- The results are based on objective measurements.
- The measurements are made in the same standardised way for all participants.
- Results are representative for the population as a whole, including people with little or no contact with health services.
- Health problems that - initially - show little or no symptoms (high blood pressure, high serum cholesterol, high blood sugar levels) but have important long-term consequences, can be brought into focus.
- The simultaneous collection of socio-demographic information makes it possible to identify population groups in whom these problems occur more frequently.

Through the combination of self-reported information on diseases and conditions, it can be assessed to what extent the public is aware of given health problems. The basic measurements carried out in this study are in line with EU recommendations. It concerns the measurement of blood pressure, weight, height and waist circumference, and determining cholesterol and sugar levels in the blood. The main results are as follows:

High blood pressure

- One in five adults has high blood pressure. Among the over-65s, this is 40%.
- If we take into account both people who actually have high blood pressure and those who potentially have it as they are taking medication for it, it appears that one in three adults (33%) is affected by this problem. Among the over-65s, this is 68%.
- Many people with high blood pressure are unaware of their condition. Only 45% of people with high blood pressure (actual or potential) report that they have this problem. Women with high blood pressure are more aware of it than men.
- Management of high blood pressure is a point of attention. Only 58% of people taking medicine for high blood pressure have a normal blood pressure level.

Serum cholesterol

Only the serum cholesterol is insufficient to assess health risks. Total cholesterol includes both "good" cholesterol (HDL cholesterol) and "bad" cholesterol (non-HDL cholesterol). There is a health risk if total cholesterol is too high compared to HDL cholesterol. This ratio is called the cholesterol ratio.

- Almost half of the adult population (47%) has a serum cholesterol level that is higher than the threshold value used for an elevated serum cholesterol level (190 mg/dl). However, only 10% have a too high cholesterol ratio.
- A too high cholesterol ratio is strongly correlated to age and gender. The most important risk group is men between the ages of 40 and 64: 23% of them have a too high cholesterol ratio. The percentage with a too high cholesterol ratio is also relatively high among men between the ages of 18 and 39 (13%) and women older than 65 (9%).
- Only one in three people with high or potentially high cholesterol levels (due to the fact that they take medication to lower their cholesterol) report this problem. Women do so more often than men, older people more often than young people.

- Only one in four men in the 40-64 age group with a high serum cholesterol level (actual or potential) reports that they have this problem.
- One in five adults uses cholesterol-lowering drugs. However, only 68% of people taking cholesterol-lowering drugs have an optimal serum cholesterol level. This percentage is lower for women than for men.

Diabetes and risk of diabetes

- One in 10 adults has diabetes. Among over-65s, this increases to 27%.
- One in three diabetes patients is unaware of the fact that they are suffering from this disease.
- 5% of the population has diabetes that is either undiagnosed or not optimally regulated.
- In addition, 5% of the adult population has elevated blood sugar levels that indicate a risk of diabetes.
- Lower educated people are more likely to have diabetes than higher educated people. Unknown or not optimally regulated diabetes occurs 3 times more often in lower educated people than in higher educated people.
- Only 82% of adults taking medicines for their diabetes have effective treatment, i.e. they have an acceptable blood sugar level.

Overweight, obesity and too high waist circumference

- 55% of the adult population is overweight, 21% is obese and 39% has a too high waist circumference. Waist circumference is considered to be a better measure for assessing health risks than body mass index (BMI).
- When people self-report, they underestimate their weight and overestimate their height. If we assume weight and height based on self-reporting, the percentage of the overweight adult population is 6% lower and the percentage of adults with obesity is 5% lower than if the results are based on measured values.
- Overweight is more common in men than in women. Obesity is equally prevalent in men and women. However, women are more likely than men to have a too high waist circumference. This is mainly because the threshold value for waist circumference is stricter for women than for men.
- The percentage of overweight and obese adults, and adults with a too high waist circumference, increases with age, decreases with the level of education and is higher in the Walloon Region than in the other two regions.

Conclusions

The national health examination survey provides important additional results compared to the 2018 health interview survey, as it allows a more accurate assessment of the scale of the diabetes and obesity epidemic in Belgium. The results also show that a lot of people have high blood pressure and too high cholesterol levels without realising it. They reinforce the message that attention to risk factors for cardiovascular disease and diabetes should remain high on the agenda of a preventive health policy. On the one hand, the aim must be to promote a healthy lifestyle (healthy diet, sufficient exercise, no smoking, moderate alcohol consumption), but on the other hand, the early identification and tackling of risk factors that are often asymptomatic or only cause non-specific symptoms, but which can cause serious health problems in the long term. From the age of 40, these risk factors are more common and a regular preventive health examination to screen for those heatlh risk is recommended.

ABBREVIATIONS

ADA	American Diabetes Association
BP	Blood pressure
BELHES	Belgian Health Examination Survey
CI	Confidence interval
BIRNH	Belgian Interuniversity Research on Nutrition and Health
BMI	Body Mass Index
CAPI	Computer Assisted Personal Interview
EHES	European Health Examination Survey
HbA1c	Glycated haemoglobin
HDL	High density lipoprotein
HES	Health examination survey
HIS	Health interview survey
IDF	International Diabetes Federation
IMA	Intermutualistic Agency
KCE	Belgian Health Care Knowledge Centre
LDL	Low density lipoprotein
MONICA	Monitoring trends and determinants in cardiovascular disease
NESCAV	Nutrition Environment and Cardiovascular Health
NHANES	National Health and Nutrition Examination Survey
RIZIV/NIHDI	National Institute for Health and Disability Insurance
SSMG	Société Scientifique de Médecine Générale
STATBEL	Statistics Belgium
ULB	Université Libre de Bruxelles
USD	United States Dollar
VCP/FCS	Food Consumption Survey
VLDL	Very low density lipoprotein
WHO	World Health Organization

INTRODUCTION

National Health Interview Surveys (HISs) have been carried out in Belgium by Sciensano since 1997 (1). It was only in 2018 that for the first time a National Health Examination Survey (HES) could be organised. Although a HES can be organised as a survey in itself, the first Belgian Health Examination Survey (BELHES), was conducted as a follow-up survey to the 2018 health interview survey. In a HES, the emphasis is on collecting objective health data that are important for health policy.

The BELHES was made possible via financing from the National Institute for Health and Disability Insurance (NIHDI). The project was carried out according to the recommendations of the European Health Examination Survey (EHES) (2). The EHES aims to standardise national health examination surveys at EU level in order to make reliable comparisons between the results obtained in the different Member States.

1. History of health examination surveys in Belgium

The first national health surveys were organised in Europe in the late 1950s and early 1960s. The focus was primarily on cardiovascular risk factors, such as high blood pressure, blood lipids, smoking and obesity. From the 1970s to the 1990s there was a gradual increase in the number of countries with national HESs and this number increased significantly after 2000. Between 2004 and 2017, national health examination surveys were organised in 14 EU countries (2). Until 2018, Belgium was one of the few EU countries that had never previously organised a national HES.

Nonetheless, Belgium has considerable experience with health surveys at the population level. As early as the 1980s, research groups from UGent and ULB were involved in the MONICA project, an international study coordinated by the World Health Organization (WHO), with the objective of measuring cardiovascular disease trends and determinants over a period of ten years and in different populations (3). Another initiative in the 1980s was the Belgian Interuniversity Research on Nutrition and Health (BIRNH), which focused on the distribution and interrelationship of significant cardiovascular risk factors, nutritional factors, mortality rates and various laboratory data (4). More recently, the Ecole de Santé Publique of the ULiège participated in the NESCAV study within the framework of the INTERREG IV A programme 2007-2013, in which objective health data were collected at population level in four European regions, including Wallonia (5).

These initiatives generated interesting data for scientific research, but since the data collection was limited to specific regions, they did not allow estimates to be made about objective health parameters at the level of Belgium as a whole.

The possibility of organising a national HES at the national level in Belgium was therefore under consideration for some time. In 2011, Sciensano organised a workshop with speakers from Belgium and abroad to reflect on the relevance and feasibility of a HES in Belgium, in the presence of policy-makers, scientists and other stakeholders. Especially with a view to European developments, this study day showed that there was a large consensus for working towards a HES in Belgium as well.

In the run-up to the preparations for the HIS2018, the possibility of a HES section in the HIS was discussed with the representatives of the Interministerial Conference on Public Health, which commissioned the HIS, and the NIHDI. This led to an agreement between Sciensano and the NIHDI in early 2017 to carry out a health examination survey on part of the HIS2018 sample. This had to take account of budgetary constraints, which meant that the sample was much smaller than originally intended. The EHES proposed a minimum sample size of 4,000 individuals for a national health examination survey (6). Although the available BELHES budget meant

that a much smaller sample (about 1100 individuals) had to be used, this number was sufficient to make estimators for Belgium with reasonable precision.

2. Objectives of the BELHES

The main objective of the BELHES is to collect objective information on health risks and the health status of the Belgian population, in conjunction with the data available in the HIS2018. An important added value of such a health examination survey is that information is obtained regarding the prevalence of diseases and risk factors that are asymptomatic, and therefore not known by the participants of the survey. High blood pressure, for example, will usually not be accompanied by symptoms, but may eventually lead to serious and irreversible health problems.

Specifically, the aim of the BELHES is to collect information at population level on biomedical risk factors for cardiovascular diseases and diabetes, in particular high blood pressure, high cholesterol and high blood sugar levels, overweight and obesity.

In addition, there are several additional objectives that will not be further covered in this report, but for which the results will be published at a later stage:

- The BELHES measured the level of cotinine and hydroxycotinine in the urine of the participants. These are biomarkers of tobacco use and passive smoking. This makes it possible to validate the indicators on smoking and passive smoking in the HIS.
- Weak muscle strength is one of the factors of in older people. In the BELHES, grip strength was measured among people aged 50 years and over. The results of this indicator will be used in further population based studies about frailty.
- By identifying salt and iodine in the urine of the BELHES participants, information can be obtained about the salt intake and possible iodine deficiency at population level.
- Certain biomarkers in the BELHES samples will be used to study the relationship between air pollution and health outcomes.
- A final objective of the BELHES is to set up a biobank with urine and blood samples collected at the population level to conduct further research in the area of public health.

3. Topics covered and structure of this report

This report covers the themes related to the EHES basic measurements, which must be incorporated into every HES, in particular:

- Blood pressure
- Serum cholesterol
- Blood sugar level and diabetes
- Anthropometry, overweight and obesity

A methodological chapter is followed by four thematic chapters. These are always structured according to the same pattern. The importance of the theme in the context of public health is explained in an introductory section. This is followed by an overview and definition of all indicators for which results have been calculated. The main indicators are then discussed and, in addition to the overall results for Belgium, any differences according to gender, age, region and education are also highlighted. Basic tables are presented at the end of the report for all indicators, in which rough figures and standardised figures for age and/or gender are presented according to gender, age, region and education. Finally, the main conclusions that can be drawn on the basis of the results are discussed.

METHODOLOGY

1. Target population and sampling

The target population of the BELHES consists of all persons aged 18 years and over living in Belgium. This target population is the same as the one in the HIS, except for the age criterion. Minors are not included in the BELHES target population for two reasons. Firstly, they are a less relevant target group for some of the basic measurements that are taken (blood pressure, blood cholesterol level, blood sugar level). Secondly, the procedure for filling in a consent form for minors is more cumbersome and taking blood samples from children is not always straightforward.

BELHES participants were recruited among the HIS2018 participants. To gain insight into the way in which the final sample was established, it is therefore necessary to know how the HIS participants were selected. This is described in detail in the methodological chapter of the HIS report (1). In essence, the method is as follows. The HIS is a household survey. The participating households are randomly selected from the National Register in 158 Belgian municipalities, which in turn are randomly selected through a systematic procedure. A maximum of 4 persons per household are surveyed. People who stay in an institution (prison, convent, psychiatric institution, etc.) are not part of the sampling frame, but elderly people in residential care are. A basic sample of 10,000 people is assumed, but over-representation of certain population groups is possible. In 2018, this was the case for the German-speaking Community. In total, between 9 January 2018 and 8 February 2019, 11,611 people participated in the HIS2018.

Along with people under the age of 18, two other groups were excluded from participation in the HES: 1) people surveyed in the HIS via a proxy and 2) people living in municipalities within the German-speaking Community. The people who were surveyed via proxy were not eligible because there is no information available for these people from the autoquestionnaire of the HIS, which includes questions about smoking behaviour, alcohol consumption and physical activity. People from the German-speaking Community make up approximately 0.6% of the Belgian population. It was estimated that the added value of including them in the sampling framework did not make up for the significant additional logistical burden that the fieldwork of the BELHES in an additional language group would entail.

For budgetary reasons, the number of surveys had to be limited to around 1100 HIS participants. The objective was to select 450 people in the Flemish Region, 350 in the Walloon Region and 300 in the Brussels Region. A pilot phase was initiated in February 2018 with the aim of testing the procedures on around 30 individuals. The actual survey started in April 2018. This was done via a quota sampling. All HIS participants who were eligible for the HES study were invited to participate. It was decided in advance that no new participants would be invited once a predefined regional objective was achieved.

2. Realised sample and participation rate

During the pilot phase, which took place in a limited number of municipalities over the period February-March 2018, 21 HIS participants were invited to participate in the BELHES. Given that the procedures did not need to be changed after the pilot phase, these persons were included in the final sample.

The recruitment of HES participants was stopped on 26 January 2019. By this time, the target number in the Brussels Region (275 instead of 300) had not been achieved, but this had been compensated by higher than expected numbers in the Flemish and Walloon Regions.

Of the 11,611 HIS participants, 5,309 were invited to participate in the BELHES. For the remaining 6,302, they did not qualify for participation in the BELHES (being under the age of 18, surveyed via proxy or living in municipalities of the German-speaking Community), or participated in the HIS before the start of the BELHES or after the BELHES quota had been reached. Of those invited to participate in BELHES, 22.3% actually participated, 70.3% declined and 7.4% could not be contacted within a reasonable time (Table 1).

Table 1 | Final participation status of the persons invited to participate, Belgian Health Examination Survey 2018

	Belgium		Flemish Region		Brussels Region		Walloon Region	
	Nbr	%	Nbr	%	Nbr	%	Nbr	%
Invited for participation	5,309	100.0	1,979	100.0	1,540	100.0	1,790	100.0
Participation	1,184	22.3	546	27.6	275	17.9	363	20.3
Declined	3,734	70.3	1,332	67.3	1,062	69.0	1,340	74.9
Could not be contacted*	391	7.4	101	5.1	203	13.2	87	4.9

** Concerns persons who, during the HIS interview, indicated that they agreed to participate in the BELHES, but could not be subsequently contacted.*

In order to calculate the participation rate in the BELHES, the persons who were not contactable were not taken into account. The participation rate is therefore defined here as the number of BELHES participants divided by the number of HIS participants invited to participate in BELHES that either participated or declined. At the level of Belgium as a whole, the participation rate was 24.1%. The participation rate was higher in the Flemish Region (29.1%) than in the Brussels Region (20.6%) and the Walloon Region (21.3%).

Figure 1 shows the participation rate by region and gender, Figure 2 by region and age. Men and women participated in equal measure, but there are significant differences in terms of age. The highest participation rate (32.6%) is found among 45-64 year olds in the Flemish Region, the lowest participation rate among 18-24 year olds in the Walloon Region.

Figure 1 | Participation rate by region and gender, Belgian Health Examination Survey 2018

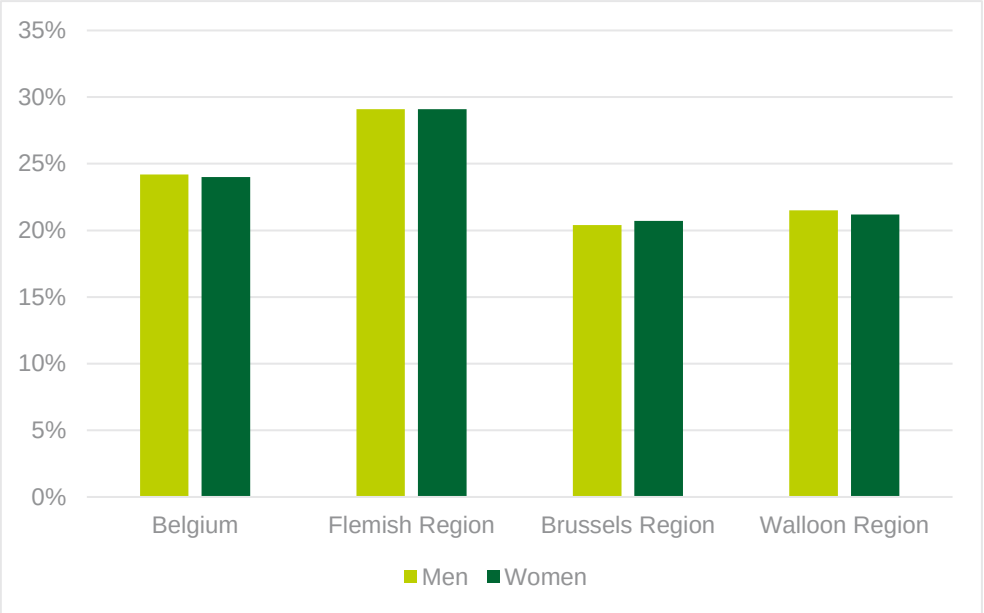
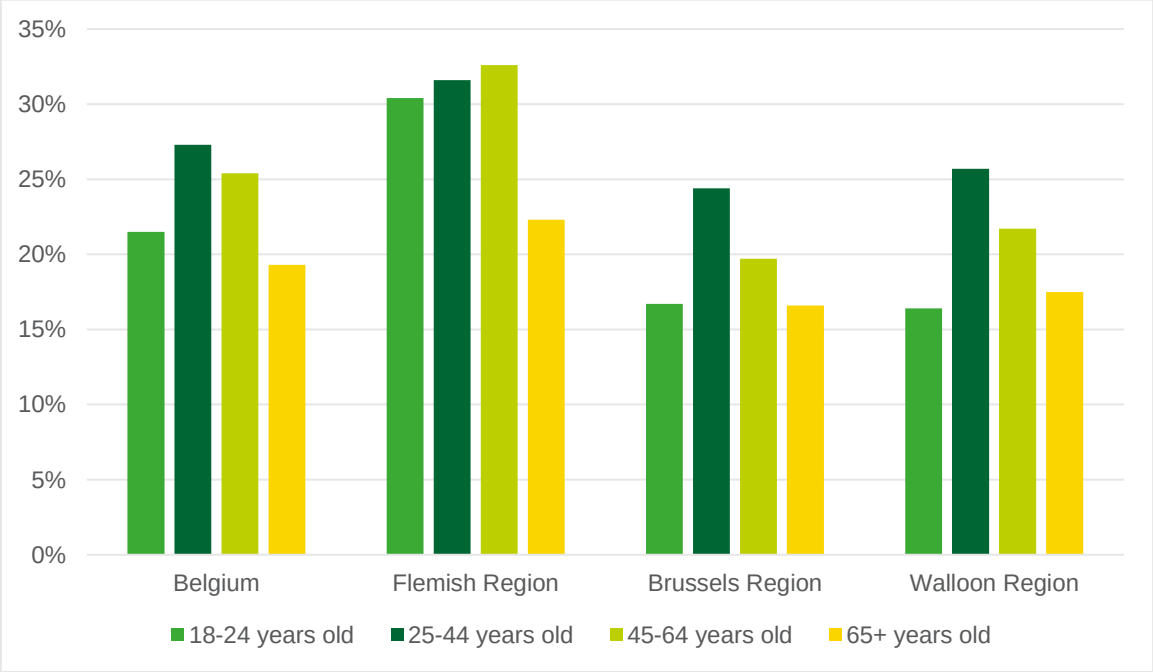


Figure 2 | Participation rate by region and age group, Belgian Health Examination Survey 2018

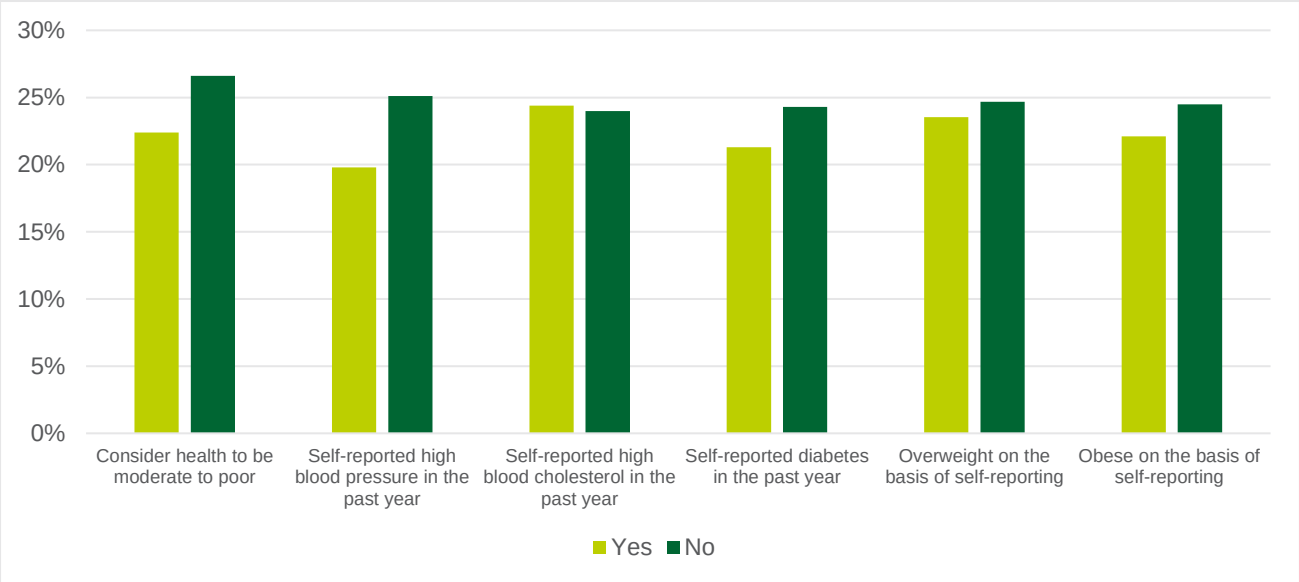


There are also significant differences depending on the level of education. Among persons without a diploma or only a primary school diploma, the participation rate is 16.5%, for persons with at most a lower secondary education 17.7%, for persons with at most a higher secondary education 24.5% and for the highest educated 26.3%. The difference in participation rate between the two lowest and the two highest education categories is significant after correcting for age and gender.

Figure 3 shows to what extent the participation rate is related to self-reported health characteristics in the HIS. As a rule, the participation rate is higher for people who do not report a health problem than for those who do. However, for only two of the indicators examined, the difference after correcting for age and gender is significant. A significantly lower participation rate is found in people who consider their health to be moderate to very poor

compared to those who consider their health as good to very good. The participation rate is also significantly lower for people who report high blood pressure than for people who do not report it.

Figure 3 | Participation rate according to self-reported health indicators in the HIS, Belgian Health Examination Survey 2018



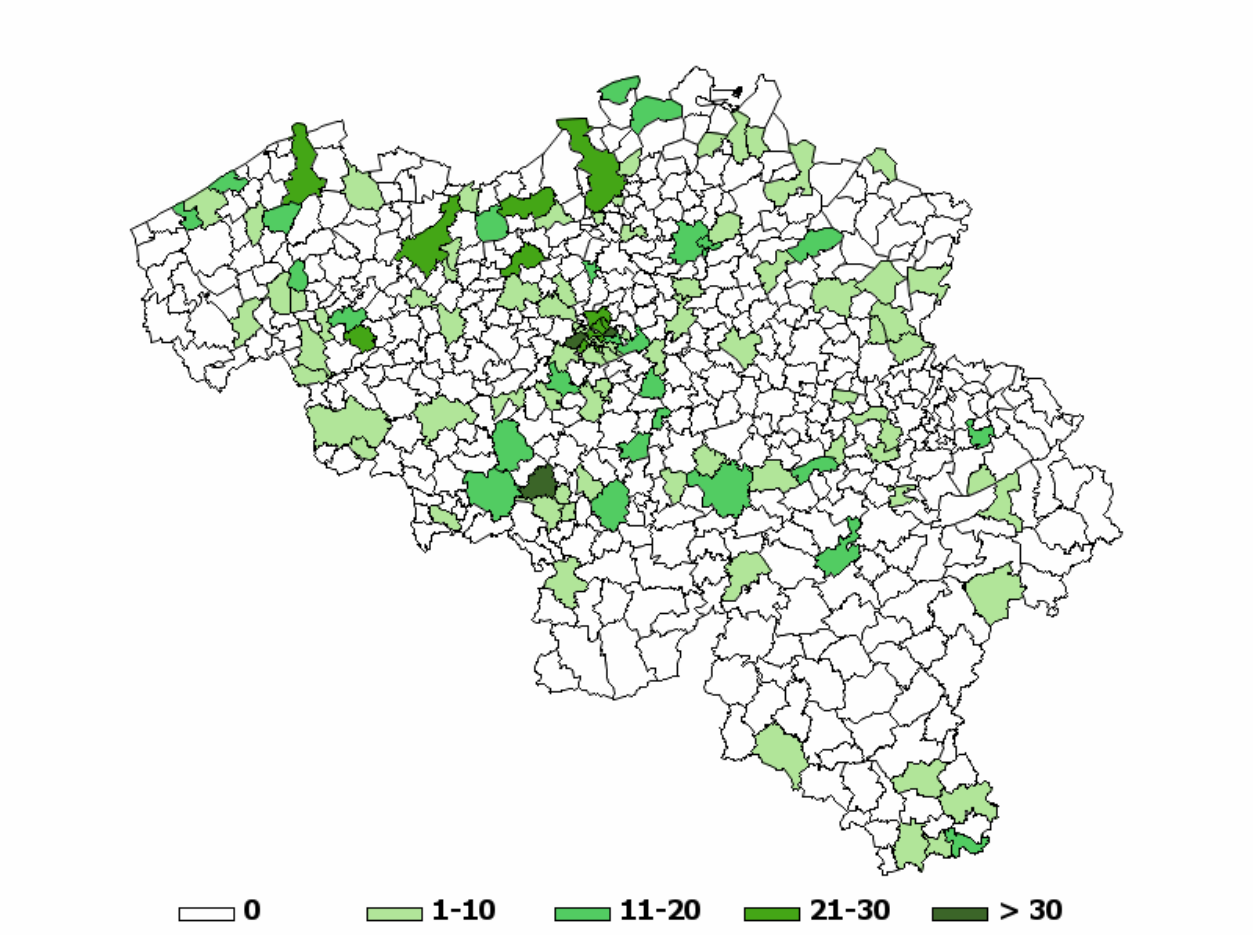
The pre-defined number of examinations (1,100) was amply reached (Table 2). In the Brussels Region, this number was slightly lower than expected, but this was compensated by a higher number in the Flemish and Walloon Regions.

Table 2 | Sample achieved, Belgian Health Examination Survey 2018

	Belgium		Flemish Region		Brussels Region		Walloon Region	
	Number	%	Number	%	Number	%	Number	%
Planned	1,100	100.0	450	100.0	300	100.0	350	100.0
Realised	1,184	107.3	546	121.3	275	91.7	363	103.7

Figure 4 shows how the BELHES participants are distributed throughout the Belgian municipalities. Of course, there were no BELHES participants in the municipalities that had not been selected for the HIS. In only 3 Belgian municipalities where the HIS was organised there were no BELHES participants.

Figure 4 | Sample distribution by municipality (number of participants per municipality), Belgian Health Examination Survey 2018



Figures 5 to 7 compare the distribution of the BELHES sample according to gender, age and province with the same distribution in the general Belgian population. Especially 18-24 year olds and over-75s are underrepresented in the BELHES sample, and to a lesser extent this is also the case for 25-34 year olds. The relatively high percentage of participants in Brussels is obviously due to the regional stratification in the HIS, which anticipates an over-representation of inhabitants of the Brussels Region. The results also show that the provinces of Antwerp, Limburg and Liège are relatively under-represented in the BELHES sample, while the provinces of West Flanders and Luxembourg are more over-represented. Differences in distribution by age, gender and province were corrected by post-stratification weightings (see below: 8. Analyses).

Figure 5 | Distribution of the BELHES sample and the Belgian population by gender, Belgian Health Examination Survey 2018

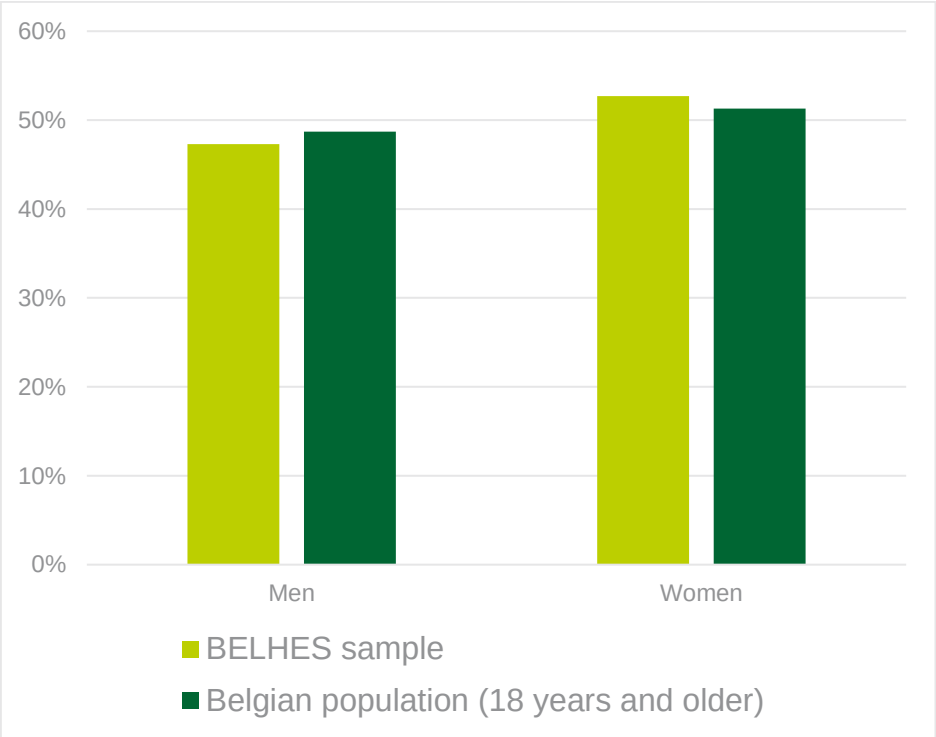


Figure 6 Distribution of the BELHES sample versus the Belgian population by age group

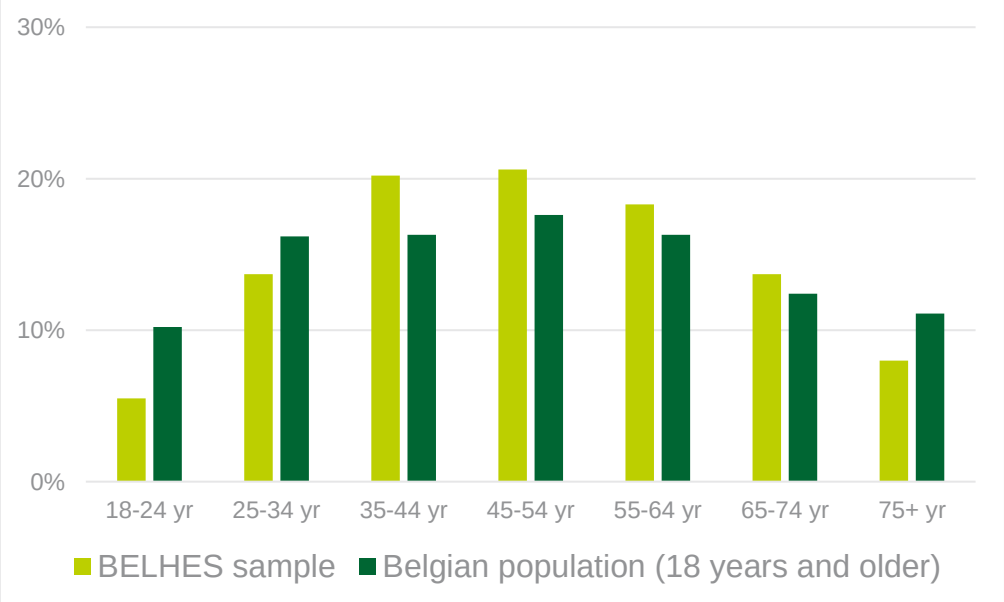
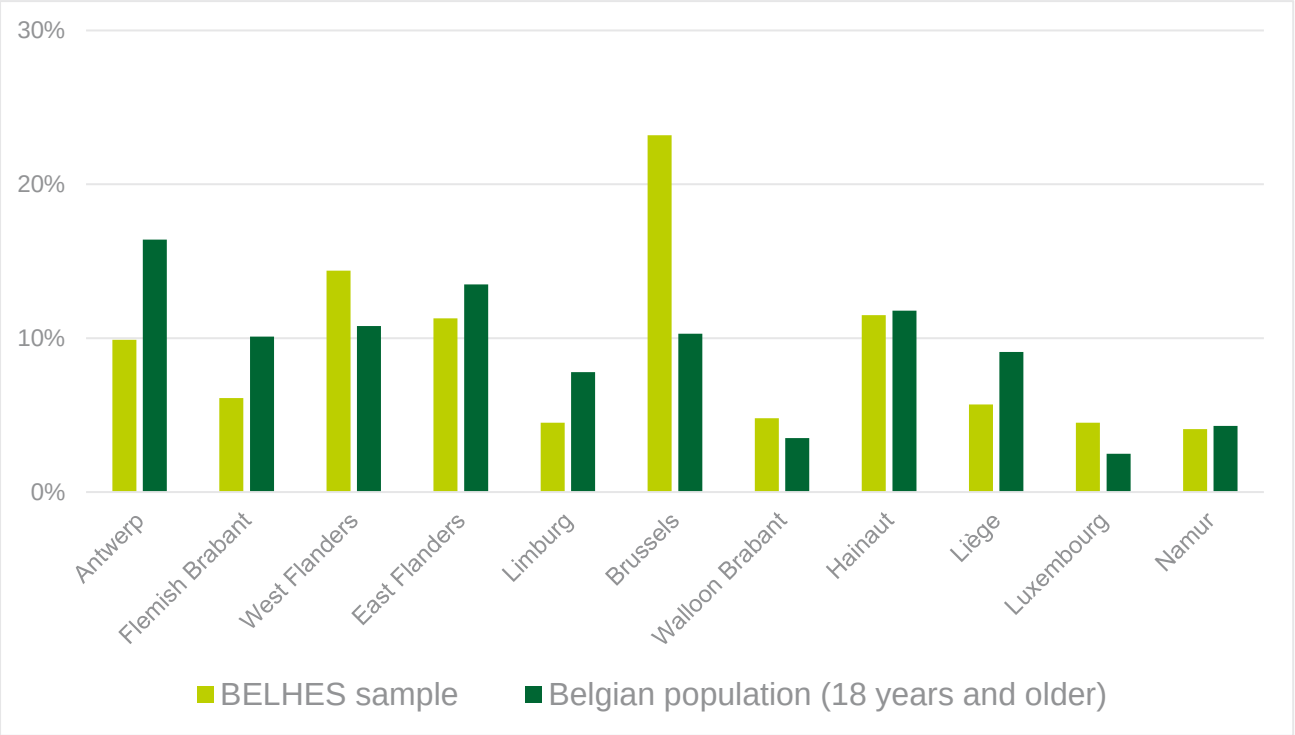


Figure 7 | Distribution of the BELHES sample and the Belgian population by province, Belgian Health Examination Survey 2018



3. Fieldwork and data collection

3.1. SELECTION OF NURSES FOR THE FIELDWORK

Via associations of Belgian nurses, self-employed nurses were identified who were willing to conduct the fieldwork. Belgium was divided up into 27 geographical zones. One nurse was selected for each zone. All nurses had to attend three training sessions. In case of a drop out, a new nurse was recruited. A total of 28 nurses carried out the examinations (see annex 1).

3.2. COOPERATION WITH THE CLINICAL LABORATORY

For reasons of standardisation, the laboratory analyses had to be carried out by one central laboratory, which had to carry out the procedures according to EHES quality criteria. A public tender was sent to all Belgian clinical laboratories. The task description included taking care of the part of the training of the nurses regarding blood collection, sampling, performing the analyses, reporting the results and metadata, aliquoting and temporary storage of samples. Via an official procedure, the contract was awarded to CERBA Healthcare Belgium, Labo CRI in Ghent.

3.3. SELECTION OF THE PARTICIPANTS VIA STATISTICS BELGIUM (STATBEL)

The BELHES was organised as a follow-up to the participation in the HIS 2018. The initial phase of the fieldwork was carried out in close cooperation with Statbel, the Belgian statistical office. In the leaflet that accompanied the letter of introduction to the persons who were invited to participate in the HIS, it was already mentioned that some HIS participants would also be invited for an additional health examination. The Statbel interviewers were briefed about this during their training. At the end of the HIS interview, HIS participants who were eligible for BELHES participation were asked whether they agreed to be contacted by a nurse for participation in the BELHES. If they agreed, they would receive a leaflet with detailed information on the procedure for the

examination and their contact details (name, address, telephone number, e-mail address, best time to contact them) would be entered. This information was then transmitted to Statbel. On a weekly basis, the contact details of the persons who wished to participate in the BELHES were communicated by Statbel to the nurse in charge of the survey and to the survey doctor, who was responsible for providing feedback of the results to the participants. The identification data was transferred via secure Statbel procedures.

3.4. THE TASK OF THE NURSES

Within three weeks after participation in the HIS, the nurse contacted the participants to make an appointment. Appointments had to be made in the morning because a fasting blood sample was required. The fieldwork was monitored via a secure web form that was only accessible to the nurse and to the BELHES data manager. Using this form, the nurse provided information for each person assigned to him or her that allowed the BELHES data manager to monitor the fieldwork, such as the date of the last attempt at contact, the date of the planned home visit, the status of the participant (no contact yet, pending, declined after initial consent, examination planned, examination carried out, etc.). The forms were imputed on a daily basis by the BELHES data manager and made it possible, among other things, to inform the lab the day before where the BELHES samples had to be collected.

Home visits could be planned on weekdays and on Saturdays and consisted of four parts:

1) First, the consent form was completed and signed. The consent form consisted of two parts. The first part was an information form that was read through with the nurse. It explained the objectives and progression of the examination, identified risks and benefits, and discussed confidentiality issues. The second part was the actual consent form. Participants could decide separately whether blood and/or urine could be stored for further research in the area of public health and whether they could be contacted again for a possible follow-up test. If the participant wanted the results to be sent to his/her GP or another doctor, the details of this doctor were noted.

2) After signing the consent form, a questionnaire was completed which included information on which medicines had been taken in the past 24 hours, whether or not women were pregnant, whether there were contraindications for blood sampling (e.g. the use of blood thinners), etc. Persons aged 50 and over were also asked some questions about the vulnerability of elderly people.

3) The various examinations were then carried out according to the instructions in the EHES manual (6).

a. Measuring blood pressure with an electronic blood pressure monitor

The participant had to sit upright and expose their right arm. They had to stand with their feet flat on the ground, back against the back of the chair, thumb pointing upwards and the arm, if possible, resting on a table. After 5 minutes of rest, without talking or moving, the blood pressure was taken three times, with an interval of 1 minute between the three measurements.

b. Measuring height

The measurement was taken without shoes on, and any accessories in the hair that could affect the measurement also had to be taken out. The participant stood on the base plate of the height meter in the middle, with their feet flat, heels against each other, and the front part of their feet apart at an angle of 60°. Their shoulders, buttocks and heels had to be in the same vertical plane. Their head had to be in the Frankfurt horizontal plane and the person had to look straight ahead. The measurement was taken after inhalation.

c. Weighing using an electronic scale

The weighing scale had to be on a hard surface. The participant was weighed without shoes or heavy clothing. The weight was taken while the participant was looking straight ahead, with their feet slightly apart and their arms next to their body. If the participant was nonetheless weighed wearing heavy clothing, this was noted down by the nurse.

d. Measuring waist circumference with a tape measure

The clothes around the torso were lifted up. Belts were loosened or removed. The participant had to stand up straight with their feet 20 cm apart and their arms next to their body. The tape measure was placed horizontally around the abdomen, halfway between the lower rib and the upper hip on the midaxillary line. Once the tape measure had been placed correctly, the waist circumference was measured after exhalation.

e. Measuring grip strength for persons aged 50 years and over.

The participant had to sit down with their back nice and straight, their feet flat on the ground and their elbow bent 90°. The dominant hand was used for this examination. The participant had to squeeze the device as hard as possible for 3 to 5 seconds so that their hand trembled. The measurement was performed 3 times with an interval of 30 to 60 seconds.

4) The last part was the collection of the blood and urine sample.

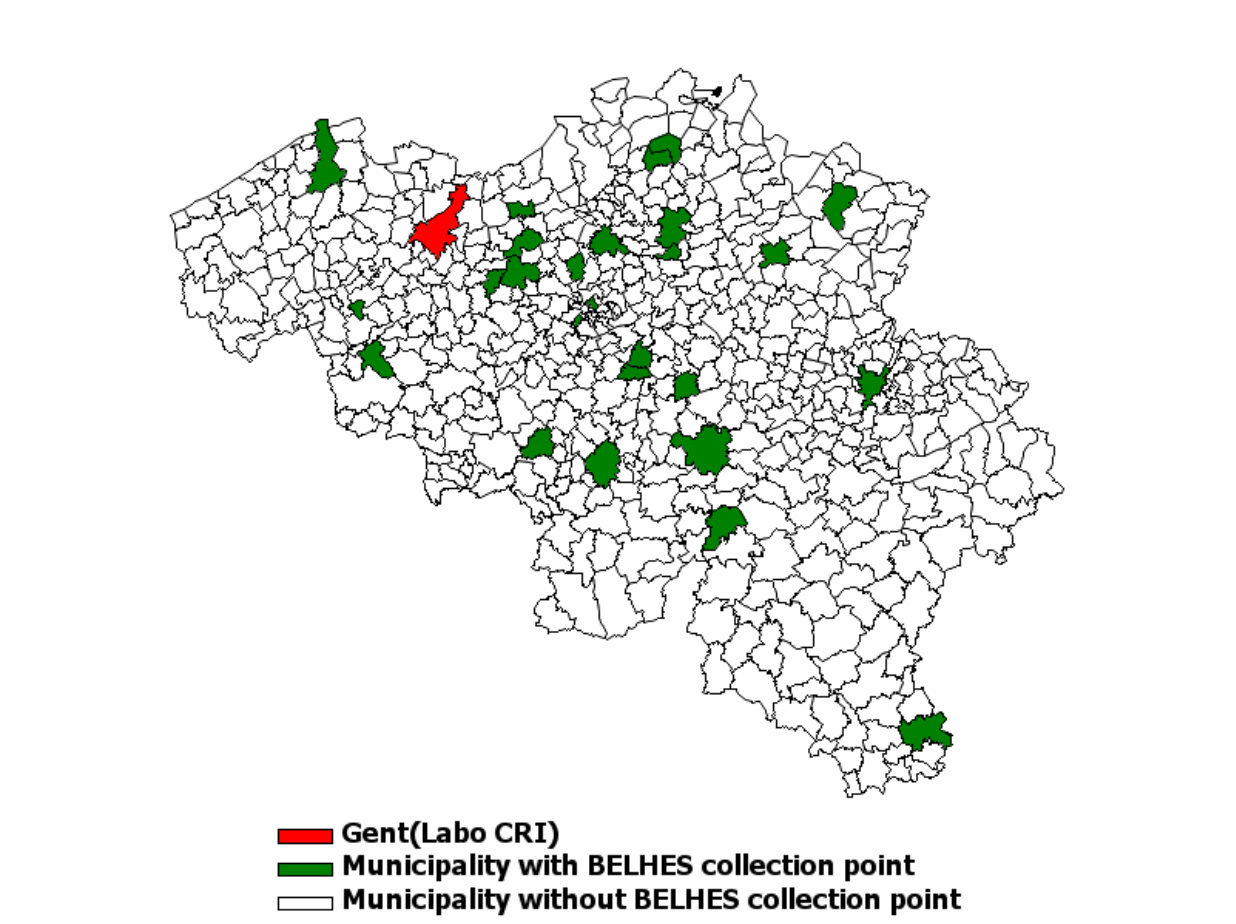
The blood sample was taken with the participant fasting and was not performed if there were contraindications. The left arm was used as a preference. Depending on whether or not consent was given to store blood for further testing, 4 or 6 tubes of blood were taken. The amount of urine to be collected was at least 50 ml.

All data and measurements were entered on PC via a CAPI (Computer Assisted Personal Interview) input programme developed in Blaise© and only generated the questions and fields that were applicable to the respondent. This reduced the risk of errors and ensured that the data collection was as efficient as possible. After the home visit, the nurse forwarded the data to Sciensano via a secure connection.

3.5. TRANSPORT AND ANALYSIS OF THE BIOLOGICAL SAMPLES

In each geographical area, partners were identified where the BELHES samples could be delivered pending collection by the laboratory. This could be the home of a nurse, a pharmacy, a hospital, a GP practice, a laboratory, etc. After the home visit, the samples were handed over by the nurse at the collection point and kept there in a cool box until the courier from the lab came to collect the samples. The collection points were spread throughout Belgium (see Figure 8). The furthest collection point (Arlon) was 253 km from the laboratory. In 98.2% of the cases, the samples were collected and analysed on the same day. The average time between blood collection and laboratory analysis was 7 hours 43 minutes (median 7 hours 37 minutes).

Figure 8 | Overview of the municipalities with BELHES collection points, Belgian Health Examination Survey 2018



4. Protecting the privacy of participants

All participants were assigned a project code and the data was processed in encrypted form. The contact details of the participants were passed on to the nurses via Statbel, but the follow-up of the fieldwork by the BELHES data manager, and the entry and transmission of the data by the nurses was done via the project code. The samples were also treated by the lab using this project code.

Only the survey doctor had access to the link between the project code and the personal data of the participants. This was necessary for the individual feedback (see next point).

All procedures were approved by the Data Protection Authority and the Medical Ethics Committee of the University Hospital Ghent.

5. Individual feedback to the participants

During the study it was explained to the participants that they would receive feedback from their GP (or other doctor of their choice) about their results. The name and address of this doctor were entered by the nurse in the input programme. Participants could also indicate whether they wished to receive the results without the intervention of their doctor.

The survey doctor was responsible for the individual feedback. Individual results, together with a description of the context of the health examination survey, were forwarded to the participant's GP. If necessary, the survey doctor contacted this doctor in person. At the same time, the participant was informed that the results had been forwarded to his or her doctor. The reason why it was decided to have the feedback go through the participant's doctor was that he or she was best placed to interpret the results.

For the individuals who had opted to receive the results without the intervention of a doctor, their results were communicated in writing via the survey doctor. If the results indicated significant deviations, the survey doctor contacted the participant by telephone.

6. BELHES data warehouse

Various data were collated to form the data warehouse of the BELHES.

- Data from the HIS
- The follow-up data of the BELHES fieldwork
- The data collected by the nurses during home visits via the CAPI questionnaire
- Results and metadata from the lab
- Data on the storage of samples in the Sciensano biobank

Thanks to a unique code number, all these data could be linked to each other.

7. Quality control

In designing the data collection tools, as many controls as possible were put in place to ensure the quality of the data. In order to test the accuracy of the link between the different files, information on gender and date of birth from the HIS, the BELHES and the National Register was compared.

Together with the laboratory, procedures were laid down to detect possible errors in the link between the data from the laboratory and the data from the fieldwork.

To verify the quality of the fieldwork, a number of participants were contacted by the survey doctor by telephone a few days after the survey. Using a short list of questions, the survey doctor enquired as to the approach of the nurse, and it was checked whether the procedures were correctly followed and whether the examinations were carried out in accordance with the agreed protocol.

Via mails and a feedback session halfway through the fieldwork, the nurses were kept informed about the progress of the fieldwork and could be given new instructions if necessary.

The BELHES project was incorporated into the Sciensano quality system and, as such, was subject to two internal audits and one external audit.

8. Analyses

As the BELHES was organised as a follow-up study to the HIS, the analysis of the BELHES data needed to take into account the stratified cluster design of the HIS, where the province is the stratification level and the household is the cluster. As in the HIS, in the BELHES different people within the same household could participate.

Population data from the National Register of 1 January 2018 were used to calculate specific BELHES weightings, which ensured that the weighted distribution of the BELHES sample in terms of age, gender and province corresponded to these distributions in the general population of 18 years and over. All results in this report take into account the survey design.

The basic tables at the end of this report present both rough figures and standardised figures according to age and/or gender. The standardisation is based on logistic and linear regression models that take into account the age and gender structure of the Belgian population.

BLOOD PRESSURE

1. Introduction

High blood pressure is defined as the pressure that the blood exerts on the arterial wall as a result of heart contractions. Arterial blood pressure is measured with a blood pressure monitor and consists of two values: systolic blood pressure is the highest value and corresponds to the pressure at the moment the heart contracts; diastolic blood pressure is the lowest value and corresponds to the pressure in the blood vessels between two contractions at the moment the heart muscle relaxes. The normal values are 120 mmHg for systolic blood pressure and 80 mmHg for diastolic blood pressure (120/80).

Systolic blood pressure of 140 mmHg or higher, or diastolic blood pressure of 90 mmHg or higher (140/90) is referred to as high blood pressure (10). However, there is a risk from a systolic blood pressure of 115 mmHg onwards, or a diastolic blood pressure from 75 mmHg onwards (11).

According to the World Health Organization (WHO), arterial hypertension or high blood pressure is responsible for 7.5 million deaths annually, or 12.8% of the total number of deaths per year worldwide. High blood pressure is one of the main risk factors for coronary artery disease and cerebrovascular disease. With a blood pressure of 115/75 mmHg and above, each increase in arterial blood pressure doubles the risk of cardiovascular disease by 20/10 mmHg (7).

According to the Belgian Cardiological League, 2.5 million adults in Belgium have high blood pressure. Only half of these have been diagnosed and only a quarter is treated (8). In 2018, the Health Interview Survey found that 17.6% of the Belgian population aged 15 years and over reported suffering from high blood pressure (9).

There are two different types of high blood pressure: primary and secondary hypertension. The vast majority of cases involve primary or essential hypertension. No unique cause for the high blood pressure can be found in this regard, but it is the result of a whole range of factors related to age, heredity and lifestyle that cause the normal regulation of the blood pressure to go wrong.

There is no treatment to definitively cure essential hypertension. Current treatments aim to lower blood pressure and prevent damage to organs such as the eyes, kidneys, brain and heart. With slightly high blood pressure, a healthy lifestyle can reduce the risk of cardiovascular disease. Since many cases of essential hypertension are not known, and high blood pressure is a "silent killer", it is always advisable to recommend a healthy lifestyle at the population level: sufficient exercise, avoiding stress, quitting smoking and lowering alcohol and salt consumption (less than 5 grams of salt per day). According to a report by the WHO, an average of 9 to 12 grams of salt per day is consumed worldwide, double the recommended dose. The WHO aims to reduce salt consumption by 30% by 2025 (13).

Usually, a person with essential hypertension will not show any specific symptoms, and it is discovered accidentally during a medical examination. In some cases, high blood pressure is associated with symptoms such as headaches, dizziness, chest pain, palpitations and nosebleeds.

5 to 10% of people with high blood pressure have secondary hypertension. This is caused by other health problems such as kidney disease, an endocrine disorder or a congenital abnormality of the aorta. Other causes are the frequent use of certain medicines and the use of illegal drugs (12).

Due to the asymptomatic nature of high blood pressure, many people do not know that they have this condition. This is an important element from the perspective of public health, as the individuals in question run a significant

health risk and action is needed to actively identify them. A health examination survey has the added value that the scale of the problem can be brought into focus. Various studies have shown that not only the prevalence of high blood pressure, but also that of diabetes and high cholesterol, estimated via self-reporting in a health interview survey and therefore based on subjective information, is underestimated compared to prevalence data obtained through a health examination survey (14).

In the BELHES, blood pressure was measured three times consecutively. The EHES guidelines were adhered to, meaning that the first blood pressure value measured is not taken into account. This may be slightly higher because the person is not yet completely calm. The blood pressure value used is the average of the second and third measured values. In addition to the blood pressure values, self-reported data are also used for the calculation of some indicators. This is information collected during the HIS in which the respondents are asked what diseases and conditions they have suffered from in the past 12 months. During the study, the BELHES participants were also asked whether they had taken medication for high blood pressure in the two weeks prior to the study.

2. Indicators

Twelve indicators were calculated according to the EHES guidelines:

2.1. BLOOD PRESSURE MEASUREMENTS

HT_01 Mean systolic blood pressure (mmHg) in the population aged 18 years and over

HT_02 Mean diastolic blood pressure (mmHg) in the population aged 18 years and over

2.2. PREVALENCE OF HIGH BLOOD PRESSURE

HT_04 Percentage of the population aged 18 years and over with high or potentially high blood pressure. These are individuals who meet at least one of the following criteria: systolic blood pressure of at least 140 mmHg, diastolic blood pressure of at least 90 mmHg, the use of medication for high blood pressure.

The information on the use of medication is based on the following question in the BELHES:

QX.01: Have you taken medicine for high blood pressure in the past 2 weeks?

HT_05 Percentage of the population aged 18 years and over with high blood pressure.
(Systolic blood pressure ≥ 140 mmHg or diastolic blood pressure ≥ 90 mmHg)

HT_06 Percentage of the population aged 18 years and over with isolated high systolic blood pressure.
(Systolic blood pressure ≥ 140 mmHg and diastolic blood pressure < 90 mmHg)

HT_07 Distribution of the population aged 18 years and over according to arterial blood pressure (BP).

Categories:

1. **Optimal**: systolic BD <120 mmHg and diastolic BP < 80 mmHg
2. **Normal**: systolic BD = 120-129 mmHg and/or diastolic BP = 80-84 mmHg
3. **High normal**: systolic BD = 130-139 mmHg and/or diastolic BP = 85-89 mmHg
4. **High blood pressure grade 1**: systolic BP = 140-159 mmHg and/or diastolic BP = 90-99 mmHg
5. **High blood pressure grade 2**: systolic BP = 160-179 mmHg and/or diastolic BP = 100-109 mmHg
6. **High blood pressure grade 3**: systolic BP ≥ 180 mmHg and/or diastolic BP ≥ 110 mmHg

2.3. INDIVIDUALS' AWARENESS THAT THEY HAVE HIGH BLOOD PRESSURE

HT_03 Percentage of the population aged 18 years and over with self-reported high blood pressure (HIS).

This indicator is based on the following question in the HIS:

MA01: Have you had any of the following diseases or conditions in the last 12 months? (Yes/No)

A list of diseases and conditions is presented, including: "High blood pressure".

Although information on this indicator is available for all HIS participants, for the purposes of this report it was only calculated for the BELHES participants.

HT_08 Percentage of the population aged 18 years and over with high or potentially high blood pressure that reports to suffer from high blood pressure (HIS-BELHES).

High blood pressure: systolic blood pressure ≥140 mmHg or diastolic blood pressure ≥ 90 mmHg

Persons with "potentially high blood pressure" are persons who have normal blood pressure but, according to the BELHES, take medication for high blood pressure.

A person who reports that they are suffering from high blood pressure means a person who answered "yes" to question MA.01 in the HIS. The following questions were also used to calculate this indicator:

QX.01: Have you taken medicine for high blood pressure in the past 2 weeks? (Yes/No)

MA01: Have you had any of the following diseases or conditions in the last 12 months? (Yes/No)

A list of diseases and conditions is presented, including: "High blood pressure".

2.4. USE OF MEDICATION FOR HIGH BLOOD PRESSURE

HT_09 Percentage of the population aged 18 years and over taking medication for high blood pressure (BELHES).

HT_10 Percentage of the population aged 18 years and over with high or potential high blood pressure taking medication for high blood pressure.

The information on the use of medication is based on the following question in the BELHES:

QX.01: Have you taken medicine for high blood pressure in the past 2 weeks?

2.5. BLOOD PRESSURE IN PERSONS TAKING MEDICATION FOR HIGH BLOOD PRESSURE

HT_11 Percentage of persons aged 18 years and over taking medication for high blood pressure have a normal blood pressure

(Systolic blood pressure < 140 mmHg and diastolic blood pressure < 90 mmHg)

The information on the use of medication is based on the following question in the BELHES:

QX.01: Have you taken medicine for high blood pressure in the past 2 weeks? (Yes/No)

2.6. HEART RATE

HT_12 Mean heart rate (heartbeats per minute) among the population aged 18 and over

3. Results

3.1. OBJECTIVE MEASUREMENTS

3.1.1. Systolic blood pressure

In Belgium, the mean systolic blood pressure in the population aged 18 and over is 121 mmHg. Men (125 mmHg) have a higher mean systolic blood pressure than women (115 mmHg). Eighty percent of men have a systolic blood pressure between 106 mmHg (10th percentile) and 146 mmHg (90th percentile). Eighty percent of women have a systolic blood pressure between 96 mmHg (10th percentile) and 140 mmHg (90th percentile).

Table 3: Systolic blood pressure in the population aged 18 and over, Belgian Health Examination Survey 2018

Gender	Mean	10th percentile	Median	90th percentile
Men	125	106	123	146
Women	115	96	112	140
Total	121	99	118	143

3.1.2. Diastolic blood pressure

In Belgium, the mean diastolic blood pressure in the population aged 18 and over is 77 mmHg. Men (79 mmHg) have a higher mean diastolic blood pressure than women (76 mmHg). Eighty percent of men have a diastolic blood pressure between 67 mmHg (10th percentile) and 92 mmHg (90th percentile). Eighty percent of women have a diastolic blood pressure between 64 mmHg (10th percentile) and 90 mmHg (90th percentile).

Table 4: Diastolic blood pressure in the population aged 18 and over, Belgian Health Examination Survey 2018

Gender	Mean	10th percentile	Median	90th percentile
Men	79	67	78	92
Women	76	64	76	90
Total	77	65	77	92

Figures 9 and 10 show the distribution of diastolic and systolic blood pressure in men and women respectively as a cumulative percentage.

Figure 9 | Cumulative percentage of blood pressure in men aged 18 and over, Belgian Health Examination Survey 2018

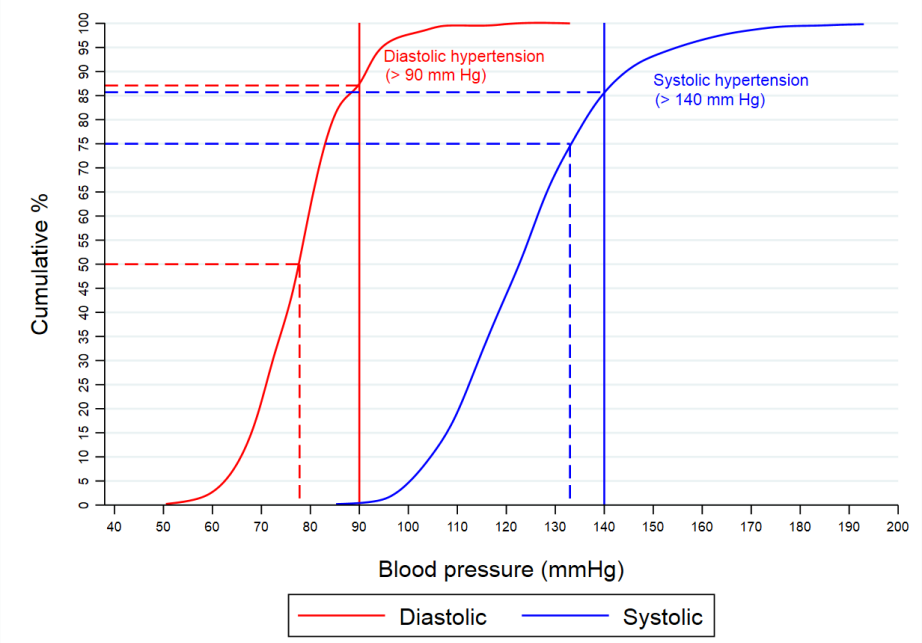


Figure 9 shows for each diastolic and systolic blood pressure value the percentage of men with a blood pressure lower than this value (= cumulative percentage). For example, 50% of men have diastolic blood pressure lower than 78 mmHg and 75% have systolic blood pressure lower than 133 mmHg. The segment to the right of the full vertical line (threshold values for high blood pressure) represents the men with high blood pressure. For diastolic blood pressure this is 13% (100% - 87%), for systolic blood pressure 14% (100% - 86%).

Figure 10 | Cumulative percentage of blood pressure in women aged 18 and over, Belgian Health Examination Survey 2018

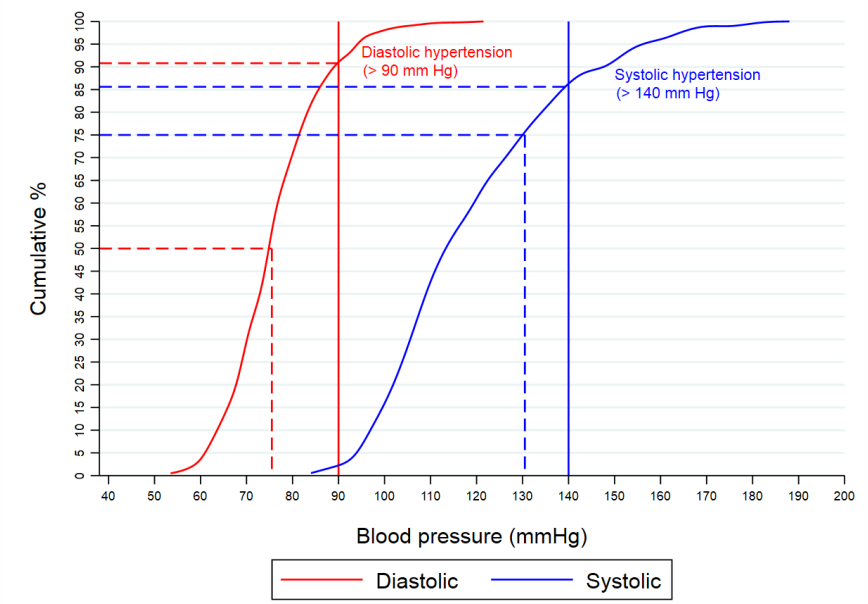


Figure 10 shows for each diastolic and systolic blood pressure value the percentage of women with a blood pressure lower than this value (= cumulative percentage). For example, 50% of women have diastolic blood pressure lower than 76 mmHg and 75% have systolic blood pressure lower than 130.5 mmHg. The segment to the right of the full vertical line (threshold values for high blood pressure) represents the women with high blood pressure. For diastolic blood pressure this is 9% (100% - 91%), for systolic blood pressure 14% (100% - 86%).

3.2. PREVALENCE OF HIGH BLOOD PRESSURE

Based on the reported data in the HIS and the BELHES, and the measured values in the BELHES, several indicators regarding the prevalence of high blood pressure were generated. Only the most relevant ones are discussed.

Table 5 shows that 15.9% of the population aged 18 years and over report that they suffer from high blood pressure. This percentage is lower than the percentage of people with a measured high blood pressure (20.0%). This therefore means that many people with high blood pressure are unaware of their condition. In total, 32.8% of the population have high or potentially high blood pressure. "Persons with potentially high blood pressure" are persons who have normal blood pressure who take medication for their high blood pressure.

Table 5 | Percentage of the population aged 18 years and over with high blood pressure according to various indicators, Belgian Health Examination Survey 2018

Indicators	Definition	Percentage
Self-reported high blood pressure	Reports having high blood pressure	15.9%
Measured high blood pressure	Systolic blood pressure ≥ 140 mmHg or diastolic blood pressure ≥ 90 mmHg	20.0%
Isolated systolic high blood pressure	Systolic blood pressure ≥ 140 mmHg and diastolic blood pressure < 90 mmHg	9.0%
High or potentially high blood pressure	Systolic blood pressure ≥ 140 mmHg or diastolic blood pressure ≥ 90 mmHg or taking medicines for blood pressure	32.8%

There are no significant differences between men and women, either for the prevalence of measured high blood pressure or the prevalence of high or potentially high blood pressure.

Table 6 | Percentage of the population aged 18 years and over with a measured high blood pressure according to gender and age, Belgian Health Examination Survey 2018

Age	Men	Women	Total
18-39 years old	5.2%	3.9%	4.6%
40-64 years old	23.6%	16.6%	20.1%
65+ years old	34.8%	44.8%	40.4%
Total	20.1%	19.9%	20.0%

Table 7 | Percentage of the population aged 18 years and over with a high or potentially high blood pressure according to gender and age, Belgian Health Examination Survey 2018

Age	Men	Women	Total
18-39 years old	6.3%	6.7%	6.6%
40-64 years old	36.3%	29.0%	32.8%
65+ years old	65.4%	69.9%	68.0%
Total	33.0%	32.6%	32.8%

When we compare Tables 6 and 7, we find that 4.6% of 18-39-year-olds have high blood pressure while 6.6% have high or potentially high blood pressure. These percentages are 20.1% and 32.8% respectively for the 40-64 age group, and 40.4% and 68.0% for the over-65s. The differences according to age are significant for both men and women.

Individuals with at most a secondary school education are more likely to have high blood pressure (24.6%) and high or potentially high blood pressure (40.9%) than the higher educated, where these percentages are 15.6% and 25.0% respectively. However, after correcting for age and gender, the differences between the two education classes are no longer significant.

The percentage of people with high or potentially high blood pressure is 37.0% in the Walloon Region, 27.8% in the Brussels Region and 31.5% in the Flemish Region, but after correcting for age and gender, there are no significant differences between the regions.

3.3. INDIVIDUALS' AWARENESS OF THEIR HIGH BLOOD PRESSURE

We define individuals who are aware of their high blood pressure as those who reported having had "high blood pressure" over the past 12 months in the HIS.

15.9% of persons aged 18 years and over reported having had high blood pressure in the past 12 months. The percentage of people with high or potentially high blood pressure (high measured value and/or use of medication) is twice as high (32.8%). Only 44.9% of people with high or potentially high blood pressure report suffering from high blood pressure (Table 8).

The percentage of people with high or potentially high blood pressure who are aware of their high blood pressure increases with age. For 18-39 year olds, this is 22.9%. For people over 65, this percentage is more than double (49.2%), just under the half. The difference between the youngest and oldest age group is large, but not significant. This may be due to a lack of statistical power because the indicator is calculated on a relatively small subgroup of the BELHES sample, in particular persons with high or potentially high blood pressure (n = 382).

No significant differences can be found for this indicator, either, depending on the region and the level of education.

Table 8 | Percentage of the population aged 18 years and over with a high or potentially high blood pressure who report suffering from high blood pressure, according to age and gender, Belgian Health Examination Survey 2018

Age	Men	Women	Total
18-39 years old	17.6%	27.5%	22.9%
40-64 years old	39.2%	48.1%	43.2%
65+ years old	43.3%	53.1%	49.2%
Total	39.7%	49.8%	44.9%

In each age group, the percentage of women with high or potentially high blood pressure reporting that they suffer from high blood pressure (27.5%, 48.1% and 53.1% respectively) is higher than the percentage of men (17.6%, 39.2% and 43.3% respectively).

3.4. USE OF MEDICATION FOR HIGH BLOOD PRESSURE

More than one in five people aged 18 and over (21.7%) reported having used medication for high blood pressure in the two weeks prior to the health examination survey. This percentage is higher for women (22.4%) than for men (20.9%).

The use of medication for high blood pressure increases with age: from 2.6% among 18-39 year olds, around 18.6% among 40-64 year olds, to 53.5% among over-65s. The differences are significant after correcting for gender.

The percentage of people who take medication for high blood pressure is twice as high among people with at most a higher secondary education (29.0%) than among people with a higher education (14.6%). However, after correcting for age and gender, this difference is not significant.

No regional differences are observed for this indicator.

66.8% of individuals with high or potentially high blood pressure reported having taken medication for high blood pressure in the two weeks prior to the health examination survey. For women this is 69.2%, for men it is significantly lower (64.3%).

The use of medication also increases sharply with age within this sub-group: from 40.6% among 18-39 year-olds and 56.9% among 40-64 year-olds to 78.9% among those aged 65 and over. After correcting for gender, the differences between the oldest age group and the two younger age groups are significant.

Here, too, no significant differences are observed according to the level of education and the region.

3.5. HIGH BLOOD PRESSURE IN PERSONS TAKING MEDICATION FOR HIGH BLOOD PRESSURE

Of those who reported that they were taking medication for high blood pressure, only 58.1% had normal blood pressure (systolic blood pressure < 140 mmHg and diastolic blood pressure < 90 mmHg).

For men this percentage is 60.3% and for women 56.1%, but after correcting for age the difference between the sexes is not significant. Differences according to age, educational level and region are not significant either, but here too the limited statistical power must be taken into account as this indicator is calculated on a relatively small subgroup (n = 254).

4. Discussion

This first Belgian health examination survey made it possible for the first time to collect information on the prevalence of high blood pressure in Belgium, on the basis of objective data. In addition, it was possible to estimate the percentage of adults with high blood pressure who are unaware of their condition.

What is the situation in Belgium according to the Belgian health examination survey?

This health examination survey shows that one in five people (20.0%) aged 18 and over have either a systolic blood pressure of at least 140 mmHg or a diastolic blood pressure of at least 90 mmHg. To get an idea of the scale of the problem of high blood pressure, we must of course also take into account people who are being treated for high blood pressure. That is why we use the term "high or potentially high blood pressure" in this report. This applies both to people whose blood pressure is too high and people who have a normal value but are taking medication for high blood pressure. One in three people aged 18 and over (32.8%) are in this category. The fact that only 44.9% of these individuals indicates that they have high blood pressure suggests that a large number of people with high blood pressure are not aware of the problem. Given that unknown and untreated high blood pressure poses a major risk for complications such as coronary artery disease and cerebrovascular diseases in the long run, this relatively low percentage gives cause for concern. The same applies to the far too high percentage of users of medication for high blood pressure who still have high blood pressure despite taking this medication: this concerns more than 40% of individuals who take medication for high blood pressure.

Comparative data

Comparing the Belgian data with those of other countries is not a straightforward task. Depending on the country, the definition and the target group may differ. The prevalence of measured high blood pressure in the population aged 18 years and over in Belgium (20.0%) is not so different from the prevalence observed in a similar health examination survey in the Grand Duchy of Luxembourg. There, the percentage of people with a measured high blood pressure was 22.0% (15). However, the target group consisted of 25 to 64 year olds.

The percentage of people with high or potentially high blood pressure in the Belgian health examination survey (32.8%) is similar to the percentage in a health examination survey carried out in Germany (32%). The target group here was 18-79-year-olds (16). In the United States, this prevalence was slightly lower than in Belgium (30.4%, also among persons aged 18 and over (17), but in Poland (target group 20-74-year-olds) this prevalence was much higher (42.7%) (18).

In France, high or potentially high blood pressure is defined as a systolic blood pressure value ≥ 140 mmHg and/or a diastolic blood pressure value ≥ 90 mmHg, or reimbursement of medicines for high blood pressure. The prevalence in France is slightly lower than in Belgium: 30.6% among 18-74 year olds. In comparison with our neighbouring countries, we can therefore assert that the prevalence of high blood pressure in Belgium is somewhere in the middle.

What is the profile of individuals with high blood pressure?

The most important factor is age. As age increases, the percentage of people with high blood pressure increases. In the Belgian health examination survey, no differences, or no significant differences, were found in terms of gender, educational level or region.

Limitations

In addition to the important added value of a health examination survey, a number of limitations should also be highlighted. Although the identified blood pressure is based on several measurements, these measurements always took place at the same time of the day. However, blood pressure values fluctuate constantly. A clinical

diagnosis will always be based on different values at different times, but in the context of a health examination survey it is not feasible to repeat the studies at different times.

It should be noted that the percentage of persons with self-reported high blood pressure was higher among HIS participants aged 18 and over (18.3%) than among BELHES participants (15.9%). This has to do with a selection bias. Persons with self-reported high blood pressure in the HIS participated in the health examination survey relatively less often than the HIS participants who did not report high blood pressure. However, this suggests that the actual prevalence of high blood pressure in the general population may be even higher than the results of the health examination survey suggest.

The relatively small sample probably also meant that the statistical power was insufficient to demonstrate given differences.

Recommendations

In order to reduce blood pressure, a change of lifestyle is often sufficient. The following measures are important: losing weight, quitting smoking, eating a Mediterranean diet, limiting salt intake, getting more exercise, moderating alcohol consumption and reducing stress. If non-medicine based treatment is not enough, taking medication is recommended.

The GP is the most appropriate person for detecting, treating and monitoring high blood pressure.

As high blood pressure is usually asymptomatic and can have important health consequences, it is important, especially from the age of 40, to have blood pressure checked regularly by a doctor. Once the diagnosis has been made, medical follow-up remains necessary.

SERUM CHOLESTEROL

1. Introduction

Cholesterol belongs to the group of lipids. Lipids are a heterogeneous group of molecules characterised by low water solubility and high solubility in organic solvents. The main lipids that circulate in the blood are cholesterol, triglycerides and phospholipids. Due to their limited solubility, they are transported as lipoproteins.

Increased blood cholesterol - below in the text we use the term "high serum cholesterol" - increases the risk of cardiovascular disease. According to the World Health Organization (WHO), one third of cases of ischaemic heart disease (of which the most important are heart attacks and angina pectoris) are due to excessive serum cholesterol (20). Globally, it is estimated that excessively high serum cholesterol causes 2.6 million deaths (4.5% of the total) and 29.7 million disability adjusted life years lost due to illness each year. Studies have shown that a 10% reduction in serum cholesterol in men aged 40 results in a 50% reduction in heart disease in the subsequent five years. A similar reduction in serum cholesterol in men aged 70 results in a reduction of heart disease by 20% in the subsequent five years.

Cholesterol is absorbed through the diet, but is also produced by the body itself. Seventy-five percent of the cholesterol is produced by the liver in the form of "very low density lipoprotein" cholesterol (VLDL cholesterol). These are particles rich in triglycerides (21). In the bloodstream, VLDL cholesterol is transformed into low density lipoprotein-cholesterol (LDL cholesterol), which acts as a building block for cell membranes, hormones such as oestrogen and testosterone and vitamin D. Too high LDL cholesterol, however, is harmful, as it plays a role in the formation of atherosclerotic plaque which causes the blood vessels to clog up.

Cholesterol can also be extracted from the tissues and transferred back to the liver as high density lipoprotein (HDL) cholesterol. This is a blood vessel protection mechanism. HDL cholesterol is therefore often referred to as "good cholesterol".

Apart from LDL cholesterol, other lipoproteins also play a role in the development of arteriosclerosis. All these lipoproteins together form non-HDL cholesterol (22). The total serum cholesterol traditionally measured during a blood sample contains both HDL cholesterol and non-HDL cholesterol. As this includes both a 'good' and a 'bad' fraction, it is incomplete to estimate the health risk solely on the basis of this measure. Therefore, HDL cholesterol and the "total /HDL cholesterol" ratio are usually measured during blood sampling (23).

Although there is no clear threshold of cholesterol levels corresponding to a cardiovascular risk, in clinical practice and in the literature, values are set from when there is a health risk. In the BELHES, the thresholds proposed by EHES are used (24). They are based on international literature (25,26).

An increased risk is defined as:

- a total serum cholesterol of 5.5 mmol/l (190 mg/dl) or higher
- HDL cholesterol of less than 1.0 mmol/l (38.7 mg/dl) in men and less than 1.2 mmol/l (46.4 mg/dl) in women
- a total/HDL cholesterol ratio higher than 5
- a non-HDL cholesterol level higher than 3.5 mmol/l (135.3 mg/dl)

The consumption of fats, in particular saturated fatty acids, has increased dramatically in the West since the end of the 19th century. Prior to that, deaths from coronary artery disease were rare. This also explains to a large extent the differences between population groups. At birth, LDL cholesterol levels are practically the same all over the world. LDL cholesterol is already increasing during childhood in countries such as the United States and the United Kingdom, and autopsies show that children from these countries already have a widespread presence of atheroma (27). Genetic aspects also play a role, but important monogenic abnormalities of the cholesterol metabolism contribute only sporadically to a too high serum cholesterol, and cardiovascular diseases at the population level. Population studies have shown that the heritability of high LDL cholesterol is about 40% (28) and that the important differences in LDL cholesterol between population groups are essentially related to diet and energy consumption. There is one important exception in this regard: the lower LDL cholesterol among African-Americans clearly has to do with a genetic variant.

Tackling high serum cholesterol should always be seen in combination with other risk factors for cardiovascular disease, such as high blood pressure, smoking and obesity, and in a broader framework of primary prevention of cardiovascular disease. This approach can include diet as well as treatment with medication. The most important group of cholesterol-lowering medicines are statins.

The data presented in this chapter are primarily based on the results of the blood analyses carried out. This is total serum cholesterol, HDL cholesterol and non-HDL cholesterol. Persons who did not have an empty stomach when their blood was taken (about 7% of the BELHES participants) were not included in the analyses.

The indicators presented in this report are based on the EHES guidelines (24). In addition to the measured values, self-reported information is also used. For example, during the BELHES study, participants were asked whether they were taking medicines to lower their blood cholesterol levels in the two weeks prior to the study. This is, of course, essential information in order to be able to evaluate a high cholesterol level. During the HIS interview, prior to the BELHES, the participants were also asked whether they had had an elevated cholesterol level in the 12 months prior to the interview. By linking this information to measured cholesterol levels, it is possible to estimate how many people have too high serum cholesterol, but are not aware of it.

2. Indicators

2.1. MEASURED CHOLESTEROL LEVELS

CL_1 Mean total serum cholesterol (mg/dl) in the population aged 18 years and over

CL_2 Mean HDL cholesterol (mg/dl) in the population aged 18 years and over

CL_3 Mean non-HDL cholesterol (mg/dl) in the population aged 18 years and over

CL_4 Mean ratio of total/HDL cholesterol in the population aged 18 years and over

2.2. PREVALENCE OF RISK DUE TO HIGH CHOLESTEROL

CL_6 Percentage of the population aged 18 years and over with high total serum cholesterol (> 190 mg/dl)

CL_7 Percentage of the population aged 18 years and over with a high or potentially high total serum cholesterol; i.e. either a measured total serum cholesterol > 190/ml, or a normal value and the use of cholesterol-lowering medicines.

The information on the use of cholesterol-lowering medicines is based on the following question in the BELHES:

QX02: Have you taken medication to reduce cholesterol in your blood in the last 2 weeks? (Yes/No)

CL_8 Distribution of the population aged 18 years and over according to total serum cholesterol, whereby the following categories are differentiated: less than 190 mg/dl, 190 to 230 mg/dl, 230 to 270 mg/dl, 270 to 310 mg/dl, 310 mg/dl or more

CL_9 Percentage of the population aged 18 years and over with low HDL cholesterol; this is lower than 38.7 mg/dl for men, and 46.4 mg/dl for women

CL_10 Percentage of the population aged 18 years and over with an elevated cholesterol risk factor (ratio total/HDL cholesterol > 5)

CL_11 Percentage of the population aged 18 years and over with high non-HDL cholesterol (> 135.3 mg/dl)

CL_12 Percentage of the population aged 18 years and over with a high or potentially high non-HDL cholesterol; i.e. a measured non-HDL cholesterol > 135.3 mg/dl, or the use of cholesterol-lowering medicines.

The information on the use of cholesterol-lowering medicines is based on the following question in the BELHES:

QX02: Have you taken medication to reduce cholesterol in your blood in the last 2 weeks? (Yes/No)

2.3. INDIVIDUALS' AWARENESS OF THEIR CHOLESTEROL LEVELS

CL_5 Percentage of the population aged 18 years and over with a self-reported high serum cholesterol

This indicator is based on the following question in the HIS:

MA01: Have you had any of the following diseases or conditions in the last 12 months? (Yes/No)

A list of diseases and conditions was presented, including:

"High blood cholesterol levels"

Although information on this indicator is available for all HIS participants, for the purposes of this report it was only calculated for the BELHES participants.

CL_13 Percentage of the population aged 18 and over with a high or potentially high total serum cholesterol who report that they have high serum cholesterol

A high serum cholesterol corresponds to a level > 190mg/dl. A potentially high total serum cholesterol refers to the use of cholesterol-lowering medicines based on question QX02 in the BELHES.

For the construction of this indicator, the answer to the following two questions was used:

QX02: Have you taken medication to reduce cholesterol in your blood in the last 2 weeks? (Yes/No)

MA01: Have you had any of the following diseases or conditions in the last 12 months? (Yes/No)

A list of diseases and conditions was presented, including:

"High blood cholesterol levels"

2.4. USE OF CHOLESTEROL-LOWERING MEDICINES

The last three indicators relate to the use of cholesterol-lowering medicines and are (whether or not in combination with the measured levels) based on the following question in the BELHES:

QX02: Have you taken medication to reduce cholesterol in your blood in the last 2 weeks? (Yes/No)

CL_14 Percentage of the population aged 18 years and over using cholesterol-lowering medicines

CL_15 Percentage of the population aged 18 years and over with high total serum (> 190 mg/dl) which takes cholesterol-lowering medicines

CL_16 Percentage of the population aged 18 years and over using cholesterol-lowering medicines, among whom total serum cholesterol is optimal (< 190 mg/dl)

3. Results

3.1. MEASURED CHOLESTEROL LEVELS

Table 9, Figure 11 and Figure 12 provide information on the distribution of the measured levels. These are therefore reference values for the Belgian population aged 18 years and over. The means are not discussed any further, but at the end of this report there are basic tables that show the means according to a number of background characteristics.

Table 9 | Distribution of serum cholesterol and cholesterol risk factor among the population aged 18 and over, Belgian Health Examination Survey 2018

	Gender	Mean	10th percentile	Median	90th percentile
Total cholesterol (mg/dl)	Men	187.9	144.6	185.0	236.4
	Women	192.5	143.4	189.2	240.6
HDL cholesterol (mg/dl)	Men	51.9	35.4	50.1	71.1
	Women	64.5	45.6	63.7	85.8
Non-HDL cholesterol (mg/dl)	Men	135.9	91.9	132.8	184.9
	Women	127.9	80.0	121.4	175.8
Ratio of total/HDL cholesterol	Men	3.8	2.4	3.6	5.4
	Women	3.1	2.1	2.9	4.4

Figure 11 | Cumulative percentage of the population aged 18 years and over, according to total serum cholesterol, Belgian Health Examination Survey 2018

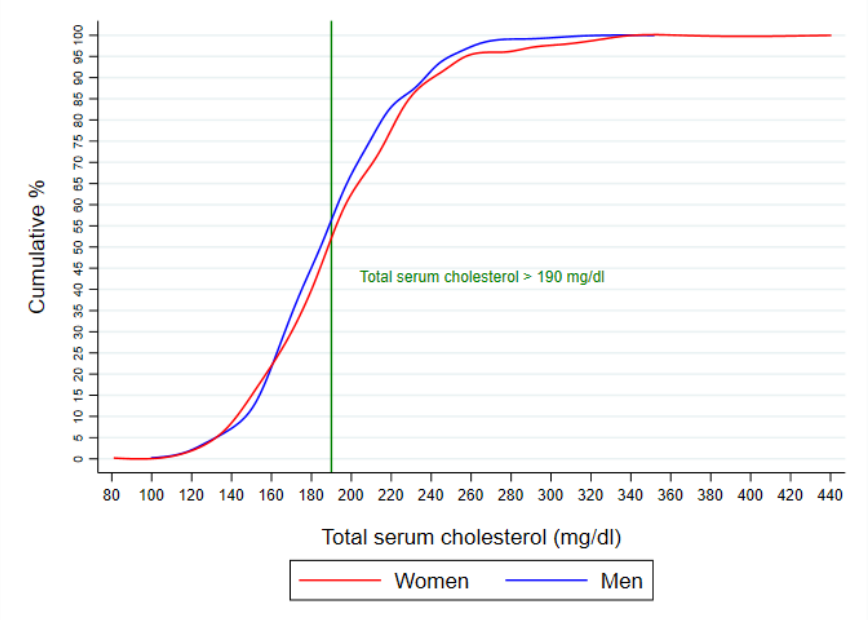


Figure 11 shows, for each value of the total serum cholesterol, the percentage of men and women who have a cholesterol level below this value. The vertical line indicates the threshold value for high cholesterol. This shows that about half of the men and women have high serum cholesterol.

Figure 12 | Cumulative percentage of the population aged 18 years and over, according to cholesterol risk factor, Belgian Health Examination Survey 2018

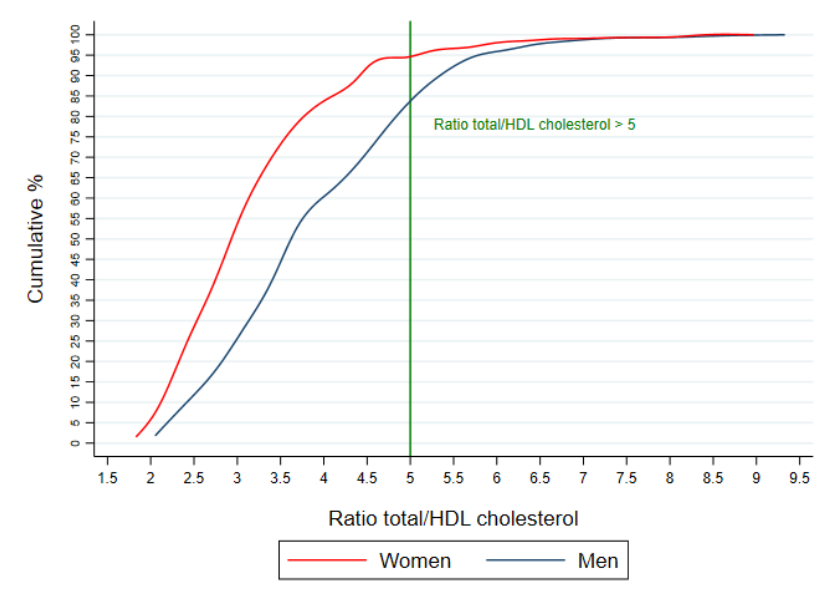


Figure 12 shows, for each value of the ratio of total/HDL cholesterol, the percentage of men and women who have a cholesterol level below this value. The vertical line indicates the threshold value for a high ratio of total/HDL cholesterol. This shows that about 5% of women and 15% of men have a high ratio of total/HDL cholesterol.

3.2. PREVALENCE OF RISK DUE TO SERUM CHOLESTEROL

Table 10 provides an overview of the main indicators. These are based on the results of the blood analyses, but also partly on self-reported information.

Table 10 | Percentage of the population aged 18 years and over with a cardiovascular risk based on blood cholesterol level, Belgian Health Examination Survey 2018

	Indicator	Definition	Percentage
CL_5	**Self-reported high cholesterol**	Declares having had high blood cholesterol in the last 12 months	20.8%
CL_6	**High total cholesterol**	Total cholesterol >190 mg/dl	46.9%
CL_9	**Low HDL cholesterol**	HDL < 38.7 mg/dl in men and < 46.4 mg/dl in women	13.7%
CL_10	**High cholesterol risk factor**	Total cholesterol/HDL cholesterol ratio > 5	9.9%
CL_11	**High non-HDL cholesterol**	Non-HDL cholesterol level > 135.3 mg/dl	42.6%
CL_7	**High or potentially high total cholesterol**	Total cholesterol level > 190 mg/dl or use of cholesterol-lowering medicines	58.3%
CL_12	**High or potentially high non-HDL cholesterol**	Non-HDL cholesterol level > 135,3 mg/dl or use of cholesterol-lowering medicines	55.4%

Depending on the indicator, the percentages vary considerably. Almost half of the population (46.9%) has too high total serum cholesterol, but this is both "good" and "bad" cholesterol. The best indicator for estimating the cardiovascular risk is the cholesterol risk factor. Approximately one in ten people (9.9%) have a high cholesterol risk factor.

Too high serum cholesterol occurs slightly more often in women (48.2%) than in men (45.0%), but the difference is not significant (Table 11). On the other hand, a high cholesterol risk factor occurs much more often in men (15.1%) than in women (4.8%) (Table 12). After correcting for age, it appears that the risk for men is 3.1 times higher than for women.

Table 11 | Percentage of the population with high serum cholesterol (> 190 mg/dl) by age and gender, Belgian Health Examination Survey 2018

Age	Men	Women	Total
18-39 years old	35.0%	28.9%	32.0%
40-64 years old	54.4%	57.0%	55.7%
65+ years old	43.1%	59.1%	52.0%
Total	45.6%	48.2%	46.9%

Table 12 | Percentage of the population with a high cholesterol risk factor (> 5) by age and gender, Belgian Health Examination Survey 2018

Age	Men	Women	Total
18-39 years old	12.5%	3.0%	7.8%
40-64 years old	22.8%	3.9%	13.5%
65+ years old	1.2%	9.2%	5.6%
Total	15.1%	4.8%	9.9%

Both men and women are more likely to have high serum cholesterol in the 40-64 age group and among the over-65s than in the 18-39 age group (Table 11). The cholesterol risk factor is especially high in men aged 40-64 (22.8%), but also one in eight men aged 18-39 (12.5%) have a high cholesterol risk factor (Table 12). Among women, it is mainly the over-65s who are at risk (9.2%).

For both indicators (total serum cholesterol and a high cholesterol risk factor) no significant differences can be observed according to the level of education, not even after correcting for age and gender.

The percentage of people with too high total serum cholesterol is significantly higher in the Walloon Region (53.8%) than in the Flemish Region (43.7%), even after correcting for age and gender. In the Brussels-Capital Region, this percentage is 46.9%. This is not significantly different from the percentage in the other two regions. In the Flemish Region, the percentage of people with a high cholesterol risk factor is 10.2%, in the Brussels Region it is 13.5% and in the Walloon Region 8.0%. These differences are not significant, even after correcting for age and gender.

3.3. INDIVIDUALS' AWARENESS OF THEIR CHOLESTEROL LEVELS

One in five people in the Belgian population aged 18 and over (20.8%) reported in the HIS that they had a too high cholesterol level in the past year. This is much lower than the percentage of people with high or potentially high total serum cholesterol (58.3%). This latter indicator includes both people with high serum cholesterol (> 190 mg/dl) and those who use cholesterol-lowering medicines. The results show that only 32.1% of people aged 18 and over with high or potentially high serum cholesterol report that they have high cholesterol levels.

The percentage of women with high or potentially high serum cholesterol that report high cholesterol is significantly higher (39.3%) than the percentage among men (25.7%). This difference is also significant after correcting for age. Awareness of high cholesterol increases with age: from 18.3% among 19-39 year olds, 28.8%

among 40-64 year olds to 46.2% among the over-65s. Table 13 provides more insight into the differences according to age and gender.

Table 13 | Percentage of the population with high or potentially high serum cholesterol who report that they have high serum cholesterol, according to age and gender, Belgian Health Examination Survey 2018

Age	Men	Women	Total
18-39 years old	15.0%	24.6%	18.3%
40-64 years old	25.5%	32.6%	28.8%
65+ years old	36.4%	53.8%	46.2%
Total	25.7%	39.3%	32.1%

There is no observable correlation between individuals' awareness of high cholesterol and their level of education, and there are no significant differences between the regions for this indicator either.

3.4. USE OF CHOLESTEROL-LOWERING MEDICINES

Almost one in five people aged 18 and over (19.0%) reported having taken medication to lower blood cholesterol levels in the two weeks prior to the BELHES study. Of the people with high total serum cholesterol, 11.4% reported having used cholesterol-lowering medicines in the two weeks prior to the BELHES study.

Men and women use cholesterol-lowering medicines in equal measure. Women with high serum cholesterol report more often (14.5%) than men (8.0%) that they use cholesterol-lowering medicines, but this difference is not significant, not even after correcting for age.

The use of cholesterol-lowering medicines increases strongly with age: from 3.0% among 18-39 year olds, 14.9% among 40-64 year olds, to almost half (48.4%) among the over-65s. People with high total serum cholesterol also show a similar increase with age: 1.0% among 18-39 year olds, 9.6% among 40-64 year olds and 25.7% among the over-65s.

The percentage of people who use cholesterol-lowering medicines does not vary according to their level of education and the region. This also applies to the use of cholesterol-lowering medicines in people who have a too high total serum cholesterol.

3.5. CHOLESTEROL LEVEL AMONG USERS OF CHOLESTEROL-LOWERING MEDICINES

Of the people who use cholesterol-lowering medicines, around two out of three (67.5%) have an optimal serum cholesterol (< 190 mg/dl). This percentage (76.5%) is significantly higher among men than among women (59.6%).

The percentage of people with optimal total serum cholesterol among users of cholesterol-lowering medicines does not vary according to age, level of education and region.

4. Discussion

The BELHES is the first study which, based on a representative sample and using objective measurements, provides information on the percentage of people with high serum cholesterol in the total Belgian population aged 18 years and over. The most common value measured when determining cholesterol levels is the total serum cholesterol. The threshold values used to determine too high serum cholesterol in examinations of the population are not always the same. For example, in the NHANES in the United States and in the Dutch health examination survey, "Nederland, de Maat Genomen", a threshold value of 240 mg/dl is used (29;30). In the national health examination survey in the Grand Duchy of Luxembourg this was 200 mg/dl (15). The EHES guidelines, which are based on WHO recommendations, use a threshold value of 190 mg/dl (30). This threshold value was adopted in the BELHES and is also used by the clinical laboratory that carried out the BELHES analyses. Based on this criterion, 47% of the Belgian population have a too high total serum cholesterol.

Comparative data

By way of comparison, in national health surveys in England (survey year 2017 - target group: adults aged 16 years and over) (31) and Germany (survey years 2008-2011 - target group: 18-79 year olds) (32), where a threshold value of 190 mg/dl was also used, this percentage was 50.0% and 58.5% respectively. In the Grand Duchy of Luxembourg (survey year 2017 - target group: 25-64 years), 49% of the population had a total serum cholesterol higher than 200 mg/dl. Based on these figures, it can be assumed that the situation in Belgium is comparable and even slightly better than in some other European countries.

Risk of cardiovascular disease

A better measure than total serum cholesterol in estimating the risk of cardiovascular disease is the ratio of total/HDL cholesterol. The mean value of this among the Belgian population is 3.2. By way of comparison, in the national survey in Germany this mean was 3.7 (32). The threshold value of the cholesterol risk factor used by EHES is 5. In Belgium, 10% of the population aged 18 and over has a risk factor higher than 5. Men in the 40-64 age group are clearly the most important risk group, but also men aged 18-39 and women aged 65 and over contain a considerable proportion of people with an increased risk.

The risk of cardiovascular disease due to high serum cholesterol must of course be considered in combination with other cardiovascular risk factors: smoking, obesity, lack of exercise, and high blood pressure. Research in recent years has clearly identified the risk according to a combination of risk factors (33).

Comparison with data from the health interview survey

An added value of a health examination survey in combination with a health interview survey is that it is possible to estimate the extent to which people are aware that their cholesterol levels are too high. For example, only one in three people who either have a high serum cholesterol or use cholesterol-lowering medicines, actually report that they have a high cholesterol level. This may be partly due to the preventive use of cholesterol-lowering medicines, for example in people who have had a heart attack or a stroke. It may also be partly due to the fact that people who use cholesterol-lowering medicines assume that they no longer have a problem. However, the results indicate that many people with too high cholesterol levels are not aware of their condition. This is more the case among men than among women. Not only are men more likely to have too high cholesterol levels, but they are also more likely than women to be unaware of it.

Strikingly, only 15% of men between 18 and 39 years of age with a high or potentially high total cholesterol are aware of it. Although European guidelines do not recommend cardiovascular risk management for men under the age of 40 without known risk factors (26), the utility of occasional screening in this age group may still need to be further looked into.

The high number of people who are unaware that they have high cholesterol is somewhat in contrast to the observation in the Health interview survey that 77% of over-18s have had a cholesterol check carried out in the last 5 years. Among over-40s, this is even 87%. This percentage could of course be even better.

The main recommendation that emerges from the results of this health examination survey is that a cholesterol check that is part of a more general cardiovascular screening for all persons aged 40 years and over, including those who feel healthy, is clearly advisable.

Use of cholesterol-lowering medicines

The BELHES also collected information on the use of cholesterol-lowering medicines, albeit on the basis of self-reporting. A striking result is that one in three people who report that they use cholesterol-lowering medicines do not have optimal serum cholesterol. The role of statins, the most commonly used group of cholesterol-lowering medicines, in primary cardiovascular prevention is an important focus and often a subject of debate. In early 2019, a study on this subject was published by the Belgian Health Care Knowledge Centre (KCE) (34). At a later stage, data from the BELHES will be linked to Farmanet data, which contains very detailed information on the use of statins. This link will undoubtedly make it possible to gain further insights into this issue.

BLOOD SUGAR LEVEL AND DIABETES

1. Introduction

Diabetes is a chronic disease that occurs when the pancreas does not produce enough insulin or when the body cannot effectively use the insulin produced. Insulin is a hormone that regulates sugar levels. Hyperglycaemia or a too high sugar level is the result of uncontrolled diabetes and can damage various bodily systems, especially the nerves and blood vessels.

According to estimates by the International Diabetes Federation (IDF), in 2017 there were 451 million diabetes patients worldwide in the 18-99 age group (35). This figure is expected to rise to 693 million by 2045. Furthermore, it is estimated that 374 million people have impaired glucose tolerance, which is the stage that precedes diabetes. In 2017, approximately 5 million deaths in the 20-99 age group were attributed to diabetes. Total global health expenditure on diabetes in 2017 was estimated at USD 850 million. Diabetes is a rapidly growing problem. Between 2005 and 2015, the number of disability adjusted life years lost due to diabetes increased from 47.9 million to 64.1 million. This is a rise of 29% (36).

There are various types of diabetes:

Type 1 diabetes is characterised by deficient insulin production and requires daily use of insulin. The cause of type 1 diabetes is not known and prevention is not possible on the basis of current knowledge. Symptoms include frequent urination, thirst, hunger, weight loss, vision problems and fatigue. The symptoms may occur suddenly.

Type 2 diabetes is the result of an ineffective use of insulin by the body. Most diabetes patients have type 2 diabetes. This form of diabetes is primarily due to obesity and a lack of physical movement. The symptoms are the same as those of type 1 diabetes, but often less pronounced, so the disease is often only diagnosed after complications have occurred.

Gestational diabetes is an elevated blood sugar level that occurs in pregnant women. Women with gestational diabetes have an increased risk of complications during pregnancy and childbirth. Both they and their children have an increased risk of type 2 diabetes.

Impaired glucose tolerance is an intermediate condition in the transition from a normal situation to diabetes. People with impaired glucose tolerance have a higher risk of developing type 2 diabetes, but this is not inevitable.

Diabetes is diagnosed by determining the glucose level in venous blood (the blood sugar level) in a person who has not eaten for at least 8 hours or has not consumed any calorific drinks. An alternative for people who are unable to take fasting blood samples is to determine HbA1c. Haemoglobin is a protein in the red blood cells to which glucose can attach itself. Haemoglobin with glucose is called glycated haemoglobin or HbA1c. Once glucose is attached to haemoglobin, it remains attached as long as the red blood cell lives. The HbA1c content is a measure of the mean blood sugar level in the preceding weeks.

According to guidelines of the American Diabetes Association (ADA) (37), which are adopted worldwide and also in Belgium (38,39), a diagnosis of diabetes mellitus can be made after two fasting glycaemic measurements on different days with a value of 126 mg/dl or more. If a fasting blood sample is not feasible, an HbA1c of 6.5% or more twice is another diagnostic option. A random glycaemia of 200 mg/dl or more in a patient with the classic symptoms of an elevated blood sugar level is also a sufficient criterion for the diagnosis.

Treating diabetes depends on the type of diabetes. Type 2 diabetes is usually treated with medication, but sometimes only non-medication based. Non-medication based treatment includes personalised dietary advice, exercise and general advice such as reducing alcohol consumption. Medication-based treatment methods include oral anti-diabetics and insulin. Type 1 diabetes patients are always treated with insulin.

The BELHES protocol provides for blood collection for determining fasting glycaemia and HbA1c levels in all participants, subject to certain exclusion criteria. For example, no blood was taken from people who used blood thinners and pregnant women. It is therefore not possible to make an estimate via BELHES of the prevalence of gestational diabetes. The BELHES sample is in any case far too small.

In the BELHES, the results of a single blood sample were used to determine the diabetes status. The strict ADA approach was therefore not followed, but a diagnosis based on a single glycaemia and determination of HbA1c is a perfectly acceptable approach. The threshold values used for the BELHES indicators are those proposed by the EHES. The EHES bases its approach on international guidelines (25,40,41).

The main objective of this chapter is to determine the prevalence of diabetes in the general population. No distinction is made between type 1 and type 2 diabetes. Blood values alone are insufficient to provide an overall view of the prevalence of diabetes at the population level. Because treated diabetes patients often have normal blood values, their use of medication must also be taken into account. During the BELHES survey, the participants were therefore asked whether they had used medication for diabetes in the two weeks prior to the survey. Information about diabetes medication in combination with blood values also makes it possible to determine the extent to which people who take diabetes medication are sufficiently regulated.

An important added value of the BELHES is that information about the blood sugar level can be linked to self-reported information about diabetes from the HIS. In this way, it is possible to estimate how many people have diabetes, but are not aware of it.

2. Indicators

2.1. MEASURED VALUES

GL_1 Mean fasting blood sugar level (mg/dl) in the population aged 18 years and over

GL_2 Mean glycolised haemoglobin (HbA1c) content (%) in the population aged 18 years and over

2.2. PREVALENCE OF DIABETES AND PREDIABETES

GL_3 Percentage of the population aged 18 years and over with self-reported diabetes

This indicator is based on the following question in the HIS:
MA01: Have you had any of the following diseases or conditions in the last 12 months? (Yes/No)
A list of diseases and conditions was presented, including diabetes.

Although information on this indicator is available for all HIS participants, for the purposes of this report it was only calculated for the BELHES participants.

GL_4 Percentage of the population aged 18 years and over with impaired glucose tolerance (fasting blood sugar level > 108 mg/dl and < 126 mg/dl)

GL_5 Percentage of the population aged 18 years and over with diabetes based on fasting blood sugar (≥ 126 mg/dl)

GL_6 Percentage of the population aged 18 years and over with diabetes based on glycated haemoglobin (HbA1C) (≥ 6.5%)

GL_7 Percentage of the population aged 18 years and over with diabetes based on fasting blood sugar (≥ 126 mg/dl) or glycated haemoglobin (≥ 6.5%)

These are people with blood values that suggest that the person is either undiagnosed as a diabetic patient or is not optimally regulated.

GL_8 Percentage of the population aged 18 years and over with diabetes based on fasting blood sugar (≥ 126 mg/dl), glycated haemoglobin (≥ 6.5%) or self-reporting

This indicator is based on the following question in the HIS:
MA01: Have you had any of the following diseases or conditions in the last 12 months? (Yes/No)
A list of diseases and conditions was presented, including diabetes.

GL_9 Percentage of the population aged 18 years and over with diabetes based on fasting blood sugar (≥ 126 mg/dl), glycated haemoglobin (≥ 6.5%) or use of diabetes medication

The information on the use of diabetes medication is based on the following question in the BELHES:
QX03: Have you taken any medication for diabetes in the last 2 weeks? (Yes/No)

The last four indicators are also based on this question (whether or not in combination with the measured values).

2.3. USE OF DIABETES MEDICATION

GL_10 Percentage of the population aged 18 years and over taking diabetes medication

GL_11 Percentage of the population aged 18 years and over with diabetes or potential diabetes and taking diabetes medication. Potential diabetes refers to poor blood values and/or the use of diabetes medication.

GL_12 Percentage of the population aged 18 years and over taking diabetes medication that is well controled (HbA1c < 7.0%)[1]

2.4. AWARENESS OF DIABETES DIAGNOSIS

GL_13 Percentage of the population aged 18 years and over with diabetes based on fasting blood sugar, HbA1c or use of diabetes medication that reports to suffer from diabetes

3. Results

3.1. MEASURED VALUES

Table 14 and Figure 13 provide information on the distribution of the measured levels. These are therefore reference values for the Belgian population aged 18 years and over. The means are not discussed any further, but at the end of this report there are basic tables that show the means according to a number of background characteristics.

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Table 14 | Distribution of the blood sugar level and the HbA1c content in the population aged 18 years and over, Belgian Health Examination Survey 2018

	Gender	Mean	10th percentile	Median	90th percentile
Blood sugar level (mg/dl)	Men	95.0	80.8	91.2	109.4
	Women	90.7	77.2	87.3	103.6
HbA1c (%)	Men	5.5	5.0	5.4	6.0
	Women	5.4	5.0	5.4	5.9

[1]This threshold is based on the recommendation of the International Diabetes Federation (43)

Figure 13 | Cumulative percentage of the population aged 18 years and over, according to fasting glycaemia, Belgian Health Examination Survey 2018

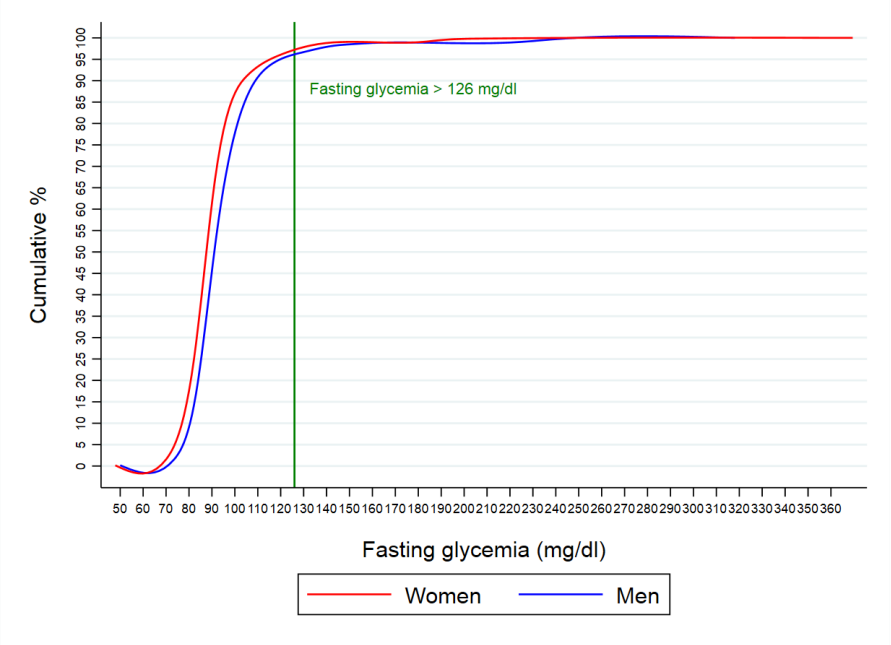

Figure 13 shows the percentage of men and women with a lower value for each fasting glycaemia value. The vertical line corresponds to the limit for diabetes. It can be inferred from this that around 5% of men and women (100% - 95%) have a fasting glycaemia value that corresponds to uncontrolled diabetes.

3.2. PREVALENCE OF DIABETES AND PREDIABETES

As expected, the prevalence of diabetes varies according to the criteria used. Table 15 provides an overview of the prevalence according to the different definitions in the EHES guidelines.

Table 15 | Percentage of the population aged 18 years and over with diabetes or prediabetes based on various criteria, Belgian Health Examination Survey 2018

Indicator	Definition used	%
GL_3	Self-reported diabetes	6.2
GL_10	Use of diabetes medication (self-reported)	7.7
GL_4	Fasting blood sugar level > 108 mg/dl and < 126 mg/dl (impaired glucose tolerance or prediabetes)*	4.6
GL_5	Fasting blood sugar level ≥ 126 mg/dl	4.0
GL_6	Glycated haemoglobin (HbA1C) ≥ 6.5%	3.2
GL_7	Fasting blood sugar level ≥ 126 mg/dl or glycated haemoglobin (HbA1C) ≥ 6.5%	4.7
GL_8	Fasting blood sugar level ≥ 126 mg/dl or glycated haemoglobin (HbA1C) ≥ 6.5% or self-reported diabetes	8.9
GL_9	Fasting blood sugar level ≥ 126 mg/dl or glycated haemoglobin (HbA1C) ≥ 6.5% or use of diabetes medication (self-reported)	10.1

** In calculating this indicator, persons using medication for diabetes were not taken into account.*

The most complete definition (indicator GL_9) is based on blood values and/or the use of diabetes medication. Based on this definition, 10.1% of the population aged 18 years and over have diabetes. 4.7% of the population has unknown or not optimally regulated diabetes (indicator GL_7). The prevalence of prediabetes or impaired glucose tolerance (indicator GL_4: fasting blood sugar level > 108 mg/dl and < 126 mg/dl) is 4.6%.

As regards a discussion of the determinants, the focus will be on these three indicators.

There are no significant differences in the prevalence of diabetes, unknown or poorly controlled diabetes and prediabetes between men and women. There is a very significant age gradient. Both the prevalence of diabetes and of unknown or poorly controlled diabetes and prediabetes increase strongly with age. The prevalence of diabetes rises from 2.3% among 18-39 year-olds, 7.5% among 40-59 year-olds to 26.7% among the over-65s. For unknown or not optimally controlled diabetes these percentages are 1.0%, 5.0% and 10.3% respectively and for prediabetes 1.1%, 4.3% and 12.0%.

Although there are indications that the prevalence of diabetes is higher in lower educated people, the differences are not significant. This is the case for unknown or poorly controlled diabetes. After correcting for age and gender, the percentage of persons with unknown or poorly controlled diabetes is 3.6 times higher for persons with at most a secondary education diploma than for persons with a higher education diploma. There are no socio-economic differences for prediabetes.

The prevalence of diabetes is significantly higher in the Walloon Region (16.2%) than in the Flemish Region (7.4%) and the Brussels Region (8.0%) and this is also the case after correcting for age and gender. In the Walloon Region, the percentage of people with unknown or poorly controlled diabetes is also significantly higher (8.7%) than in the Flemish Region (2.9%). There are no regional differences in the prevalence of prediabetes.

3.3. USE OF DIABETES MEDICATION

Of the population aged 18 years and over, 7.7% takes diabetes medication. Of all persons with diabetes (according to the most general criterion) 85.6% use medication. Of those taking diabetes medication, 81.8% are sufficiently regulated, i.e. they have an HbA1c content < 7.0%. This threshold is based on the recommendations of the International Diabetes Federation (43)

The determinants of the use of diabetes medication are the same as for the prevalence of diabetes, which is of course logical. The BELHES sample is too small to make any assertions about population characteristics associated with effective regulation of blood values in people taking diabetes medication.

3.4. AWARENESS OF DIABETES DIAGNOSIS

Of all persons with diabetes, according to the broadest possible definition, i.e. persons who either have impaired blood values that correspond to a diabetes diagnosis or they take diabetes medication, 63.4% identify themselves as diabetes patients. More than one in three diabetes patients is therefore undiagnosed. The BELHES sample is too small to make assertions about population characteristics correlated with undiagnosed diabetes.

4. Discussion

Information on the prevalence of diabetes in Belgium

The BELHES makes an important contribution to estimating the actual prevalence of diabetes in Belgium. Of course there are other sources in Belgium that make it possible to estimate the prevalence of diabetes. The Inter-mutualist Agency publishes prevalence figures for diabetes based on medication use in its IMA Atlas (43). The most recent data (2016) indicate a prevalence for Belgium of 6.1%. In the health interview survey, the prevalence was measured on the basis of self-reporting. In 2018, the prevalence of diabetes in Belgium among the population aged 15 years and over, based on self-reported information, was 5.9%. The Intego network collects incidence and prevalence rates of diseases and conditions in a representative network of Flemish GPs (44). Based on their figures, the prevalence in Flanders in 2015 was 0.4% for type 1 diabetes and 6.4% for type 2 diabetes. Each of these sources has limitations. The IMA figures do not include diabetes patients who are not taking any medication. In the case of self-reported data, there may be a problem with the validity of the information because people themselves do not always assess their diagnosis correctly, are not aware of it, or report incorrectly. The Intego data are only available for Flanders and only relate to the GP patient population.

The added value of a health examination survey

Although the figures from the sources mentioned above are fairly similar, they all have the same shortcoming: they do not provide information on undiagnosed diabetes patients. Indeed, diabetes is a disease that entails few symptoms in the early stages, and few specific symptoms in particular. As such, a lot of diabetes patients stay under the radar. The WHO estimates that one in two diabetes patients worldwide do not know they have the condition (45) It is only through national health examination surveys that we can get an overview of undiagnosed diabetes patients.

The main results of the health examination survey

The key figures that emerge from this health examination survey are that 10% of the population aged 18 and over in Belgium has diabetes, that a little more than one in three diabetes patients (37%) is undiagnosed and that 18% of the patients who take diabetes medication still have a too high blood sugar level. 5% of the population has unknown or poorly controlled diabetes. Of those who do not have diabetes, 5% have a high risk of developing diabetes.

The figure for undiagnosed diabetes is compatible with the figures from other Western countries. In the NHANES, the total prevalence of diabetes in adults aged 20 years and over was 14%, of which 4.3% was undiagnosed (46).

Socio-economic disparities

The first report of the health examination survey, in which results were presented on self-reported diabetes, already suggested that there was an increase in the prevalence of diabetes according to age and a decrease in prevalence as the level of education increases. The BELHES results provide further insights into socio-economic disparities. Although there are no differences in education level regarding the prevalence of prediabetes and the use of diabetes medication, it is clear that undiagnosed or poorly controlled diabetes is much more common in the lower education categories than among the most highly educated. This suggests that there are socio-economic disparities in the transition from prediabetes to diabetes and in the detection and outcome of diabetes treatment.

The presence of significant socio-economic disparities in biological markers of diabetes is an objective factor that we cannot ignore and that has also been identified elsewhere (47). This of course needs to be taken into account in the prevention, screening and treatment of diabetes. However, it is also necessary to look at the mechanisms which lead to the existence of socio-economic disparities. Solutions need to sought outside the health sector in this regard (48).

Diabetes screening

The observation that one in three diabetes patients does not know they have the condition highlights the need for further intensive screening for diabetes. The health interview survey showed that 70% of people aged 15 years and over and 81% of people over 40 had themselves tested to determine their blood sugar levels in the three years prior to the interview. However, efforts to identify diabetes patients at an early stage still need to be stepped up. Both Domus Medica and the Société Scientifique de Médecine Générale (SSMG) have well-developed guidelines for diabetes screening in general practice (38.39) using the FINDRISC score. The FINDRISC score is based on age, body mass index (BMI), waist circumference, use of anti-hypertensive medicines, daily physical activity, eating fruit and vegetables, temporarily impaired glucose metabolism and occurrence of diabetes in the family, and helps to identify persons with an increased risk of diabetes in whom it is appropriate to take fasting blood sugar levels.

Quality of care for diabetes patients

Finally, the BELHES also calculates an outcome indicator of the quality of care for diabetes patients. 12% of patients taking diabetes medication do not have good blood values. This of course also means that the diabetes is well controlled in 88% of patients. It would have been interesting to examine which socio-demographic characteristics are associated with this outcome indicator, but unfortunately the sample was too small. This also applies to better profiling the people with undiagnosed diabetes.

ANTHROPOMETRY, OVERWEIGHT AND OBESITY

1. Introduction

In recent decades, overweight and obesity has increased at an alarming rate in most regions of the world. According to estimates made by the WHO, 39% of adults aged 18 years and over were overweight in 2016, of whom 13% were obese. 18% of children and adolescents aged 5 to 19 were overweight in 2016 (49). In Europe, the figures are even more worrying. According to Eurostat data, 52% of European citizens were overweight in 2017, of whom 15% were obese. The increase in overweight and obesity is one of the most important public health problems in developed countries today. Overweight is an important risk factor for cardiovascular disease, type 2 diabetes and certain cancers and increases the risk of premature death (49).

The Body Mass Index (BMI) is a simple measure that is frequently used to estimate overweight and obesity in adults. This index shows an individual's weight divided by their height squared (kg/m²). A BMI less than 18.5 kg/m² is considered to be underweight. Overweight occurs when the BMI is equal to or higher than 25 kg/m², and obesity is from 30 kg/m². In Belgium, the health interview survey 2018 revealed that 49.3% of the adult population was overweight, of whom 15.9% were obese (50).

Although BMI is an important indicator to monitor the evolution of obesity in the population, it does not provide information on fat distribution in the body. However, excess abdominal fat is associated with a high risk of heart disease, diabetes, certain cancers and premature death, regardless of the BMI figure (51). As such, it is more relevant to define overweight not only via BMI, but also through a measure of abdominal obesity (i.e. excessive accumulation of body fat in the abdomen) (52). Various studies have shown that the waist circumference is a better measure to estimate the risk of cardiovascular disease, diabetes and premature death than the BMI (53). Threshold values have been established to indicate the proportion of the population with a too large waist circumference. It is assumed that there is a mild increase in metabolic complications with an waist circumference of 80 cm for women and 94 cm for men, and a large increase in this risk with an waist circumference of 88 and 102 cm respectively (53). Only the latter thresholds were used in the BELHES.

In the health interview survey, the BMI was calculated based on the weight and height reported by the respondents. Self-reporting is the most common way to collect these data in a population survey. This method is practical, quick, easy, inexpensive and allows for a large number of people to be surveyed. Overweight and obesity calculated on the basis of self-reported measurements are associated with a higher risk of morbidity and early death (54), but there are limitations: not all participants will understand the question in the same way; sometimes an individual only has vague knowledge about their height and weight and the values are rounded off; and finally, given the sensitivity of the subject, there is a problem of social desirability. Participants tend to overestimate their height and underestimate their weight, and this is even more the case in overweight and obese people. This phenomenon leads to an underestimation of the BMI and thus an underestimation of the prevalence of overweight and obesity in the population (55). The influence of social desirability may evolve over time as social and cultural norms as regards weight change (56). The over-estimation of height on the part of older people may be due to the fact that they shrink with age (57).

To avoid this bias, it is recommended that data be collected through measurements by health professionals, rather than relying on self-reported information (6.58). As such, it is essential for the Belgian health examination survey to estimate the prevalence of overweight and obesity in Belgium as standardised and accurately as possible.

2. Indicators

The questions and examinations in the Belgian health examination survey (BELHES) are based on the recommendations of the EHES (6).

The anthropometric measurements taken by the nurses are as follows:

- Height in centimetres (without shoes);
- Weight in kilograms (in light clothing and without shoes);
- If the nurse indicated that the person had been weighed with heavy clothing (5% of participants), a standardisation was applied. According to the recommendations of Whigham et al., 0.8 kg and 1.2 kg were deducted from the weight for women and men respectively (59).
- Waist circumference in centimetres (without clothing or in light clothing).

Based on the weight, height and waist circumference, the following indicators were calculated:

2.1. MEASUREMENTS FROM THE HEALTH EXAMINATION SURVEY

These indicators are based on the full sample of the health examination survey ("A" indicators).

AM_1A Mean height (in cm) of population aged 18 years and over (measured)

AM_4A Mean weight (in kg) of population aged 18 years and over (measured)

AM_8A Mean body mass index (BMI) of the population aged 18 years and over (based on measured height and weight). The BMI corresponds to the weight in kg divided by the height squared (kg/m²).

AM_13A Distribution of the population aged 18 years and over according to BMI category (based on measured height and weight): (1) underweight (BMI < 18.5), (2) normal (BMI 18.5-24.9), (3) overweight (BMI 25-29.9), (4) obesity (BMI ≥ 30).

AM_11A Percentage of population aged 18 years and over with overweight (BMI ≥ 25) (based on measured height and weight)

AM_12A Percentage of population aged 18 years and over with obesity (BMI ≥ 30) (based on measured height and weight)

AM_7A Mean waist circumference (in cm) of population aged 18 years and over (measured)

AM_17A Percentage of the population with a too large waist circumference (> 88 cm for women and > 102 for men)

2.2. SELF-REPORTED MEASUREMENTS IN THE HEALTH INTERVIEW SURVEY

The indicators originate from the health interview survey, but only concern the participants in the health examination survey whose measurements were taken within 90 days after the interview ("B" indicators).

AM_2B Mean height (in cm) of population aged 18 years and over (self-reported)

To determine the self-reported height, the following question was asked:

NS.01 How tall are you without shoes on? (... cm)

AM_5B Mean weight (in kg) of population aged 18 years and over (self-reported)

To determine the self-reported weight, the following question was asked:

NS.02.B How much do you weigh without clothing and without shoes on? (... kg)

If the person was pregnant at the time of the interview, their weight prior to the pregnancy was asked.

AM_9B Mean BMI of the population aged 18 years and over (based on self-reported height and weight)

AM_14B Percentage of population aged 18 years and over with overweight (BMI ≥ 25) (based on self-reported height and weight)

AM_15B Percentage of population aged 18 years and over with obesity (BMI ≥ 30) (based on self-reported height and weight)

AM_16B Distribution of the population according to BMI category (based on self-reported height and weight)

2.3. DIFFERENCE BETWEEN OBJECTIVE MEASUREMENTS AND SELF-REPORTED RESULTS

For the purpose of this comparison, only objective measurements of persons who were examined within 90 days after participation in the HIS 2018 (88% of participants) were taken, in order to avoid possible fluctuations in the weight between participation in the HIS and the health examination survey ("B" indicators).

AM_3B Mean difference between measured and self-reported height (in cm) in the population aged 18 years and over

AM_6B Mean difference between measured and self-reported weight (in kg) in the population aged 18 years and over

AM_10B Mean difference between BMI based on measured height and weight and BMI based on self-reported height and weight in the population aged 18 years and over

3. Results

3.1. OBJECTIVE MEASUREMENTS

In the first instance, the results of the objective measurements are shown. Several indicators are grouped and presented together. For more detailed results, please refer to the tables at the end of this chapter.

3.1.1. Measured height

In Belgium in 2018, the mean height of an adult male was 176.8 cm and of an adult female 163.1 cm. Table 15 shows the distribution of height: 80% of men have a height between 167 cm (10th percentile) and 186 cm (90th percentile) and 80% of women have a height between 153 cm (10th percentile) and 172 cm (90th percentile).

Table 15 | Measured height (in cm) of the population aged 18 years and over according to gender, Belgian Health Examination Survey 2018

Gender	Mean	10th percentile	Median	90th percentile
Men	176.8	167.0	177.0	186.0
Women	163.1	153.0	163.3	172.0

Height decreases with age. Persons with a higher education diploma are taller than persons with at most an upper secondary diploma. The differences are significant. There are also regional differences: inhabitants of the Flemish Region are on average about 3 cm taller than inhabitants of the Brussels and Walloon Regions.

Figure 14 | Cumulative percentage of the population aged 18 years and over according to height and gender, Belgian Health Examination Survey 2018

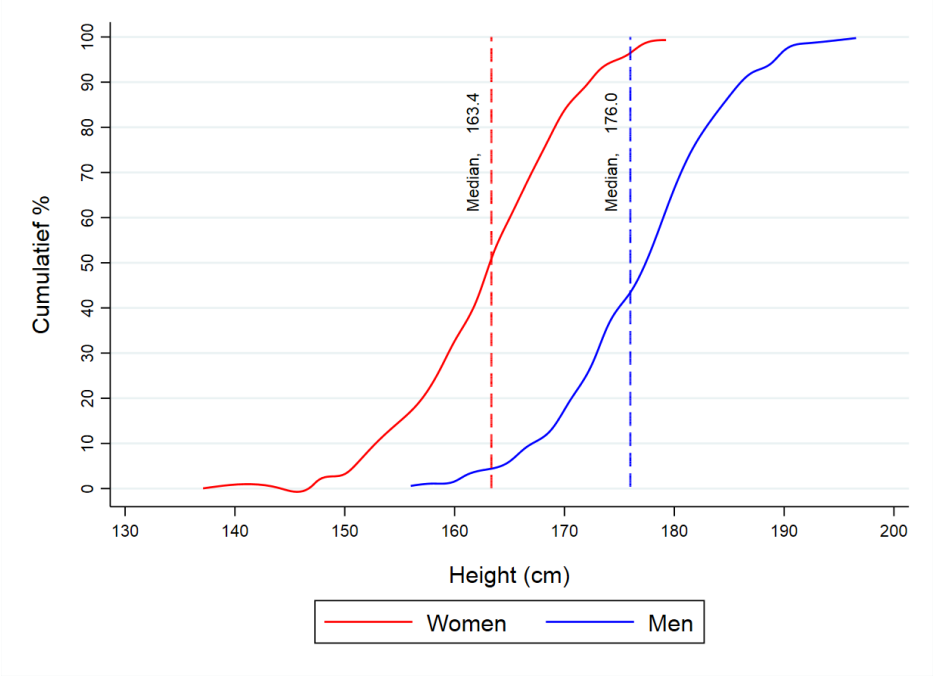

Figure 14 shows for each height (X-axis) the percentage (Y-axis) of men or women below the indicated height. The vertical line indicates the median. This shows that 50% of women are shorter than 163.4 cm (and 50% are therefore taller). Another example: the cumulative percentage for the height 170 cm is around 20%. This means that around 20% of men are shorter than 170 cm and 80% are taller.

3.1.2. Measured weight

In Belgium in 2018, the mean weight of an adult man was 83.8 kg and the mean weight of an adult woman was 70.4 kg. Table 16 shows the weight distribution: 80% of men weigh between 66.6 kg (10th percentile) and 102.2 kg (90th percentile) and 80% of women weigh between 54.4 kg (10th percentile) and 91.1 kg (90th percentile).

Table 16 | Measured weight of the population aged 18 years and over according to gender, Belgian Health Examination Survey 2018

Gender	Mean	10th percentile	Median	90th percentile
Men	83.3	66.6	81.7	102.2
Women	70.4	54.4	68.6	91.1

The mean weight is higher in the 40-64 age group than in the 18-39 age group. There are no differences according to the level of education. On average, Brussels residents weigh less than people from Wallonia and Flanders.

Figure 15 | Cumulative percentage of the population aged 18 years and over according to weight and gender, Belgian Health Examination Survey 2018

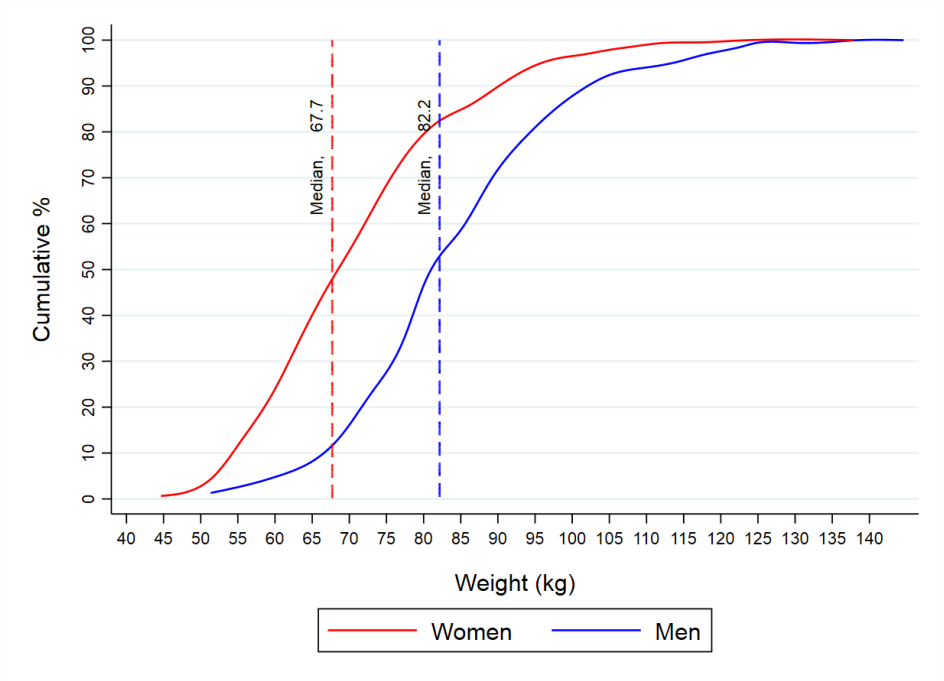

Figure 15 shows for each weight (X-axis) the percentage (Y-axis) of men or women below the indicated weight. The vertical line indicates the median. This shows that 50% of women weigh less than 67.7 kg (and 50% therefore weigh more). Another example: the cumulative percentage for the weight 90.0 kg is around 70%. This means that around 70% of men weigh less than 90.0 kg (and 30% therefore weigh more).

3.1.3. Body mass index (BMI) based on measured values

3.1.3.1. Overall results

In Belgium in 2018, the mean BMI, based on measured values, among the population aged 18 years and over was 26.6. This means that the average Belgian is too fat. 2.0% of the adult population have a BMI less than 18.5 and are therefore underweight. 42.6% of adults have a BMI between 18.5 and 24.9 and have a normal body weight. The majority of the adult population (55.4%) is overweight (BMI ≥ 25),. Among these, 21.2% are obese (BMI ≥ 30).

Figure 16 | Cumulative percentage of the population aged 18 years and over according to BMI and gender, Belgian Health Examination Survey 2018

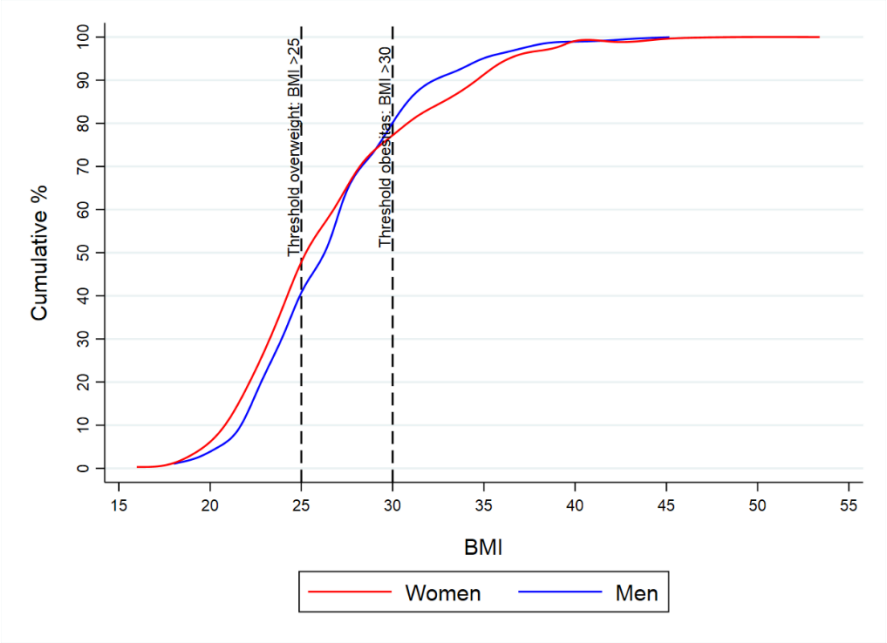

Figure 16 shows for each BMI value (X-axis) the percentage (Y-axis) of men and women below the indicated value. The vertical lines indicate the threshold values for overweight (BMI ≥ 25) and obesity (BMI ≥ 30). The threshold values are the same for men as for women. The percentage of women below the threshold value for overweight (48.3%) is higher than the percentage of men (40.7%). The percentage of women below the threshold value for obesity (77.4%) is, however, lower than the percentage of men (80.4%).

3.1.3.2. Socio-demographic differences

The mean BMI value, the percentage of underweight persons and the percentage of obese persons is not significantly different between men and women. However, the percentage of overweight men (BMI ≥ 25) (59.3%) is significantly higher than the percentage of women (51.7%).

Underweight is particularly prevalent among 18-39 year olds (3.9%) and in Brussels (3.4%) and Wallonia (3.2%). A normal weight is more common among 18-39 year-olds (59.4%), the highest educated (51.4%), Flemish (47.6%) and Brussels residents (45.4%).

Overweight (BMI ≥ 25) is correlated with age. Whereas "only" 36.7% of people aged 18-39 are overweight, this percentage is 74.2% for people aged 65 and over. At a young age, women tend to be less inclined to display overweight than men, but this is no longer the case for the over-65s. The same applies for obesity. Obesity increases from 11.8% among 18-39 year olds to 28.8% among the over-65s. Among older people (65 years and over) obesity is more common among women than among men (Table 17). The percentage of overweight (BMI ≥ 25) and obese people is higher among people with at most upper secondary education (respectively 65% and 26.6%) than among the highest educated people (respectively 46.7% and 15.9%). A higher percentage of overweight people (BMI ≥ 25) and obese people is observed in the Walloon Region (65.0% and 26.7%) than in the Brussels Region (51.2% and 17.3%) and the Flemish Region (51.3% and 19.0%) (Table 19).

Table 17 | Percentage of the population aged 18 years and over that are overweight (BMI ≥ 25) and obese (BMI ≥ 30), Belgian Health Examination Survey 2018

Age	Men		Women		Total	
	% overweight	% obesity	% overweight	% obesity	% overweight	% obesity
18-39 years old	45.4	12.9	27.3	10.6	36.7	11.8
40-64 years old	62.9	23.8	54.5	23.6	58.7	23.7
65+ years old	73.3	21.3	74.9	34.6	74.2	28.8
Total	**59.3**	**19.6**	**51.7**	**22.6**	**55.4**	**21.2**

3.1.4. Measured waist circumference

In Belgium in 2018, the mean waist circumference of an adult male was 95.8 cm and of an adult female 88.6 cm. Just under three-quarters of men have an waist circumference below the threshold of 102 cm, whereas in just over half of women the waist circumference is below the threshold of 88 cm. These values increase with age. The differences according to age are significant for both men and women.

Figure 17 | Cumulative percentage of the population aged 18 years and over according to waist circumference and gender, Belgian Health Examination Survey 2018

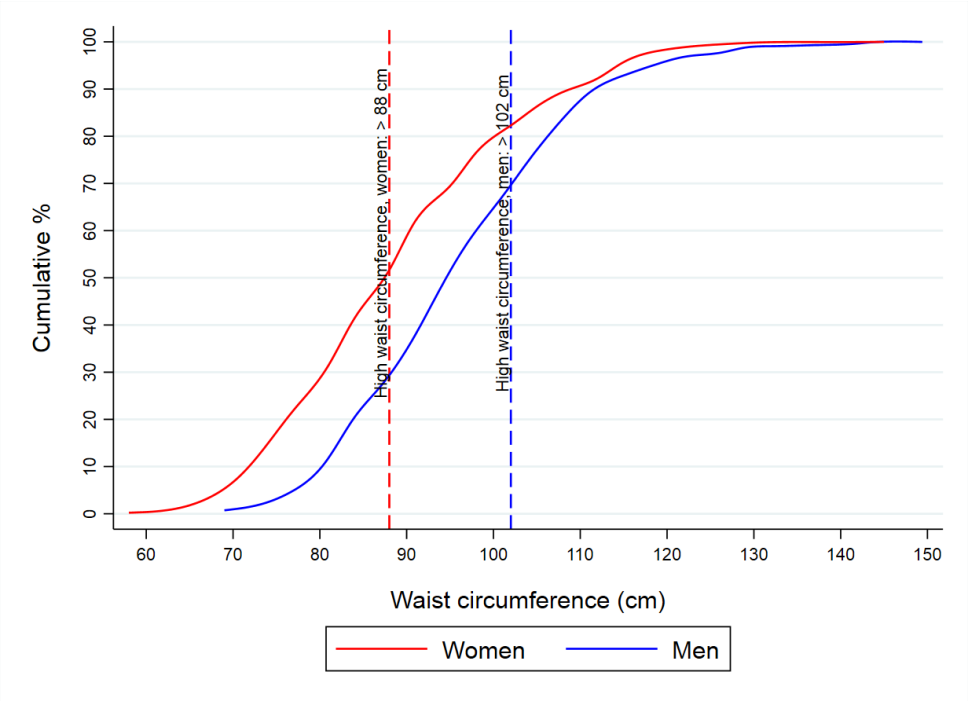

Figure 17 shows for each waist circumference value (X-axis) the percentage (Y-axis) of men and women below the indicated value. The first vertical line indicates the threshold value for women (88 cm) and the second line shows the threshold value for men (102 cm). In this figure, we therefore observe that 52.7% of women have an waist circumference below the threshold value of 88 cm and 70.5% of men have an waist circumference below the threshold value of 102 cm.

Table 18 | Percentage of the population aged 18 years and over with a too large waist circumference (men > 102 cm - women > 88 cm). Belgian Health Examination Survey 2018

Age	Men	Women	Total
18-39 years old	19.8%	20.8%	20.2%
40-64 years old	30.2%	50.3%	40.1%
65+ years old	43.5%	72.5%	59.9%
Total	29.5%	47.3%	38.6%

The results show that 29.5% of men and 47.3% of women have a too large waist circumference, i.e. an waist circumference larger than 102 cm and 88 cm respectively. The percentage of people with a too large waist circumference increases with age: from 20.2% among 18-39 year olds to 59.9% among people over 65. The increase is greater among women than among men (Table 18). Waist circumference also seems to increase as the level of education decreases. The figure is 47.3% for persons with at most a secondary education, and 30.4% for persons with a higher education. The difference is significant. In the Walloon Region, the percentage of people with a too large waist circumference is higher than in the other two regions, but only the difference with the Brussels Region is significant (Table 19).

Table 19 | Percentage of the population aged 18 years and over who are overweight (BMI ≥ 25), obese (BMI ≥ 30) and have a too large waist circumference (men > 102 cm - women > 88 cm), by gender, age, educational level and region, Belgian Health Examination Survey 2018

		% overweight	% obesity	% too large waist circumference
Total		55.4	21.2	38.6
Gender	Men	59.3	19.6	29.5
	Women	51.7	22.6	47.3
Age	18-39 years old	36.7	11.8	20.2
	40-64 years old	58.7	23.7	40.1
	65+ years old	74.2	28.8	59.9
Education	At most secondary	65.0	26.6	47.3
	Higher education	46.7	15.9	30.4
Region	Flanders	51.3	19.0	36.2
	Brussels	51.2	17.3	34.0
	Wallonia	65.0	26.7	44.7

3.2. DIFFERENCES BETWEEN THE OBJECTIVE MEASUREMENTS AND SELF-REPORTED VALUES

For all BELHES participants for whom the interval between participation in the health interview survey and participation in the health examination survey was maximum 90 days (n = 1014), the results of the self-reported anthropometric values in the health interview survey were compared with the measured values from the health examination survey.

It was observed that men overestimate their height by an average of 0.8 cm; in women this is 1.4 cm. Men underestimate their weight on average by 1.5 kg, women by 1.8 kg. This has repercussions for the calculation of the BMI. The BMI based on the measured values is on average 0.9 higher than on the basis of self-reported values, i.e. 0.7 for men and 1.2 for women.

If measured values are used, the percentage of overweight and obese persons is 6.4% and 5.4% higher, respectively, than if these percentages were calculated on the basis of self-reported values. These differences are significant. The differences are greater in women than in men, but the difference in estimators between men and women is not significant.

Table 20 | Differences in anthropometric values between results based on measurements (HES) and results based on self-reporting (HIS)

Measurements	Respondents	Differences	
	N= 1014	Difference	95% confidence interval
Height (cm)	Men	-0.8	(-1.1;-0.5)
	Women	-1.4	(-1.8;-1.1)
Weight (kg)	Men	1.5	(1.1;1.9)
	Women	1.8	(1.3;2.2)
BMI (kg/m²)	Men	0.7	(0.6;0.9)
	Women	1.2	(1.0;1.3)
	Total	**0.9**	**(0.8;1.1)**
Overweight (%)	Men	5.7	(2.9;8.6)
	Women	6.4	(3.5;9.1)
	Total	**6.0**	**(4.0;8.0)**
Obesity (%)	Men	4.9	(2.3;7.5)
	Women	5.8	(2.9;8.8)
	Total	**5.4**	**(3.4;7.4)**

4. Discussion

A health examination survey has various advantages. Anthropometric values based on a clinical examination (measuring height, weight and waist circumference) make it possible to correct for the distortion that occurs with self-reporting. In addition, the waist circumference can also be measured, meaning that information can be obtained about the distribution of abdominal fat. Due to the high risk of overweight and obesity in terms of morbidity and early death (49), it is important to have the most accurate figures possible so that these problems can be properly followed-up and necessary preventive measures can be taken.

Synthesis and interpretation of the results

The Belgian health examination survey shows that overweight and obesity are significant problems in Belgium. Based on objective measurements, it was observed that more than half of the population (55.4%) is overweight and one fifth (21.2%) is obese. These figures are higher for the elderly, people with lower education levels and people living in the Walloon Region. In addition, just under one third (29.5%) of men and almost half (47.3%) of women have a too large waist circumference. The latter difference between the two sexes has to do with the significant difference in threshold value that is used to define a too large waist circumference.
These measured anthropometric values are the "gold standard" compared to the results based on self-reporting. The results of the BELHES make it possible to compare both results with the same persons, and they reveal that people overestimate their height and underestimate their weight compared to objective measurements. This results in an underestimation of the mean BMI and the percentage of overweight and obese people, when

self-reported values are used. This is confirmed by literature data and the results of the food consumption survey (FCS) carried out by Sciensano in 2014 (52,55,56).

Correction for wearing heavy clothing

The BELHES methodology specified that participants should be weighed in their underwear or light clothing. If this recommendation was not adhered to, it was reported by the nurses and a correction factor was used in the analysis (59).

Internal validity

Participation in the health examination survey required greater motivation from the participants (2nd home visit and more invasive procedures) than participation in the health interview survey. It is possible that this resulted in a selection bias that affects the results. In order to evaluate the internal validity of the results of the health examination survey as regards BMI, overweight and obesity, a comparison was made between self-reported indicators (from the health interview survey) in the sample in the health examination survey (n = 1152) and the same self-reported indicators in the full sample in the health interview survey (n = 9594). The mean value of the BMI based on self-reported values is very similar in both samples (Table 21). The small differences in the percentage of overweight and obese people based on self-reported values are not significant. It can be concluded from this that selection bias had little or no influence on the results of the anthropometric values in the health examination survey, at least when compared to the full sample of the health interview survey.

Table 21 | Comparison of anthropometric values among the population aged 18 years and over based on self-reporting between the sample of the health examination survey and the sample of the health interview survey, Belgian Health Examination Survey 2018

		Sample **health examination survey**		Sample **health interview survey**	
N		**1152**		**9594**	
		%	95% confidence interval (CI)	%	95% confidence interval (CI)
BMI	Men	26.0	(25.5-26.4)	25.9	(25.8-26.1)
	Women	25.4	(24.9-25.9)	25.0	(24.8-25.2)
	Total	**25.7**	**(25.3-26.0)**	**25.5**	**(25.3-25.6)**
% overweight	Men	53.5	(47.9-59.2)	55.3	(53.3-57.4)
	Women	45.5	(40.5-50.5)	43.4	(41.5-45.4)
	Total	**49.5**	**(45.6-53.4)**	**49.3**	**(47.8-50.7)**
% obesity	Men	14.3	(10.9-17.6)	16.7	(15.2-18.2)
	Women	16.6	(12.7-20.5)	15.0	(13.7-16.4)
	Total	**15.4**	**(12.8-18.1)**	**15.9**	**(14.8-16.9)**

Comparative data

In order to make a comparison with data from the Belgian food consumption survey of 2014, the figures from the Belgian health examination survey were recalculated for the age group 18-64 years. We observed that the percentage of overweight and obesity among women is lower in the Belgian health examination survey (43.2% and 17.7% respectively) than in the food consumption survey (48.1% and 20.1% respectively). However, due to the limited sample size, there is an overlap of the 95% confidence intervals, so we cannot assume that there are significant differences between the results of both surveys.

Table 22 | Comparison of the percentage of overweight and obese people in the 18-64 age group between the Belgian Health Examination Survey 2018 and the Food Consumption Survey (FCS) 2014.

		BELHES 2018		FCS 2014	
		%	95% CI	%	95% CI
% overweight	Men	55.5	(48.8-62.1)	57.9	(53.0-62.7)
	Women	43.5	(37.9-48.6)	48.1	(43.3-53.0)
	Total	**49.5**	**(45.0-54.0)**	**53.1**	**(49.6-56.5)**
% obesity	Men	18.6	(13.5-23.8)	18.9	(15.1-22.6)
	Women	17.7	(13.5-22.0)	20.1	(16.0-24.2)
	Total	**18.2**	**(14.8-21.6)**	**19.5**	**(16.7-22.2)**

The results of the Belgian health examination survey are similar to those of the Grand Duchy of Luxembourg, where a national health examination survey was also organised between 2013 and 2015. In the Luxembourg survey, 51.5% of the population were overweight based on self-reported figures (49.5% in the BHIS) and 57.2% were overweight based on measured values (55.4% in the BELHES). The difference between the two estimates was 5.7% in Belgium and 6.0% in Luxembourg. In Luxembourg, 17.0% of the population were obese based on self-reporting (15.4% in the BHIS), while this percentage was 20.3% based on measured values (21.2% in the BELHES). The difference between the results based on self-reporting and objective measurements was 3.3% in Luxembourg and 5.4% in Belgium (15).

Conclusion

We can conclude that, by 2018, a significant proportion of the population in Belgium was overweight and/or had a too large waist circumference. The health examination survey shows that this share of the population is even greater if objective measures are used. That is why it is essential to implement actions that promote healthy eating habits and sufficient physical activity. Educational policies, especially in schools, can be an effective tool for preventing obesity in all socio-economic groups.

GENERAL DISCUSSION

In 2018 and 2019, a national health examination survey was organised for the first time in Belgium, the BELHES. The work to implement the BELHES drew significantly on the European guidelines that were developed in recent years within the framework of the EHES initiative, a collaboration between experts from different EU Member States, with the aim of collecting comparable, high-quality data on health and health risks in the adult European population.

The BELHES was carried out on part of the sample from the health interview survey 2018. By calculating weighting factors, the results are representative of the total Belgian population.

The results in this report are based on the basic measurements recommended by the EHES:

- Measuring blood pressure
- Measuring body weight and height
- Measuring the waist circumference
- Determining serum cholesterol
- Determining blood sugar level
- Determining glycated haemoglobin in the blood

Via these measurements, objective information was collected on the occurrence of important risk factors of cardiovascular diseases in the general adult population of Belgium. For example, it was observed that 20% of adults have high blood pressure and 10% have a high cholesterol risk factor. Based on measured values of height and weight, it was ascertained that 55% of the adult population is overweight, whereas on the basis of self-reporting this is "only" 49%. Thirty-nine percent of people aged 18 years and over have an unhealthy waist circumference, an indicator that reflects the risk of cardiovascular disease even better than the BMI.

The results of the BELHES are an important complement to earlier results of the health interview survey 2018 (50,60,61) and only reinforce the message that attention to risk factors for cardiovascular disease should remain high on the agenda of a preventive health policy. On the one hand, the aim must be to promote a healthy lifestyle (healthy diet, sufficient exercise, no smoking, moderate alcohol consumption), but on the other hand, the early identification and tackling of risk factors that are often asymptomatic or cause non-specific symptoms, such as high blood pressure, high serum cholesterol and a too high blood sugar level, but which can cause serious health problems in the long term. It is essentially a combination of factors that determines the risk. GPs are best placed to assess this risk, provide appropriate health advice and, if necessary, start treatment.

The fact that one in three people with diabetes are not aware that they are suffering from this disease is one important result of the BELHES. Up until now, it was assumed that a large number of diabetes patients were undiagnosed, but the BELHES now also applies a figure based on objective measurements in the general population. The underestimation of the problem of overweight and obesity on the basis of self-reported data has also been brought into focus. As such, the BELHES has made it possible to estimate the scale of the diabetes and obesity epidemic in our country more accurately.

Several indicators have been calculated that pertain to the outcome of the care. For example, only 58% of people taking medication for high blood pressure have an optimal blood pressure level, 68% of people taking

cholesterol-lowering medicines have an optimal serum cholesterol level and 89% of people taking diabetes medication have a well-regulated blood sugar level. It is difficult to determine which factors play a role in this regard. These can be related to medical follow-up, therapy compliance, the context, etc. The data from the BELHES do not allow for further investigation. However, these figures are useful because they can be used as a benchmark for similar population surveys in the future.

We ought to mention some of the limitations of this survey as well. According to the EHES guidelines, the minimum sample for a national health examination survey is 4,000 persons (6). For budgetary reasons, the sample of BELHES had to be limited to just under 1200 persons. This is sufficient for calculating overall estimators, but for a thorough study of determinants and making estimates in subpopulations, a larger sample is needed. For any subsequent HES, it needs to be ensured that the minimum sample size required by EHES is more or less achieved.

It should also be noted that there may be a selection bias, as participants in the BELHES may be systematically different from non-participants. A comparison between BELHES participants and HIS respondents who did not participate in the BELHES because they declined or could not be contacted again showed that the BELHES participants more often reported that their health was good to very good compared to non-participants. This "healthy volunteer effect" could mean that the results presented here are actually rosier than the actual situation.

Finally, it should also be noted that the way in which clinical diagnoses such as high blood pressure and diabetes are operationalised in a HES is less accurate than diagnoses in clinical practice, which are generally based on different measurements at different times.

However, the overall conclusion is that the BELHES has produced valuable results. To gain insight into the extent to which different risk factors occur simultaneously at the population level, the data on cardiovascular risk factors will be further explored. Indeed, one of the benefits of the BELHES is that simultaneous information is available about weight and height, waist circumference, blood lipids, blood sugar levels, blood pressure, but also about exercise, smoking and eating habits. The most important topics were covered in this report, but not all data were included. Other topics will be covered in additional publications. The BELHES samples of the persons who gave the relevant consent were also stored in a biobank and links are envisaged with other databases. The ultimate aim is to get as much as possible out of the data from this first national health examination survey and gain further information and insights that will be useful for a proactive health policy.

REFERENCES

LIST OF TABLES

Table B 8. **Percentage of the population aged 18 years and over with high or potentially high blood pressure** that reports to suffer from high blood pressure**

Table B 9.	Percentage of the population aged 18 years and over taking medication for high blood pressure

Table B 10.	Percentage of the population aged 18 years and over with high or potential high blood pressure** taking medication for high blood pressure

Table B 11.	Percentage of persons aged 18 years and over taking medication for high blood pressure have a normal blood pressure

Table B 12. Mean heart rate (heartbeats per minute) among the population aged 18 and over

Table B 25. **Percentage of the population aged 18 and over with a high or potentially high total serum cholesterol** who report that they have high serum cholesterol**

ANNEX 1

The following nurses were responsible for carrying out the fieldwork of the Belgian health examination survey:

Baudry Fabian - Schaarbeek
Beyers Ellen - Zoersel
Campanis Annemie - Peer
Dandrifosse Jacqueline - Angleur
De Wit Natalie - Wolvertem
Decuyper Nathalie – Chatelineau
Dedeurwaerder Gudrun – Deerlijk
El Abboudi Mimount - Dworp
Faes Sonja - Baal
Farina Valéria – Strépy-Bracquegnies
Gijbels Jim - Lummen
Laeremans Dirk - Westerlo
Lamont Bina - Melle
Magis Florence - Kain
Mukendi Yvon - Oudegem
Ngungu Patrick - Ghlin
Nyakuate Martinien – Namur
Ouled Salem Ali – Braine-le-Château
Raes Bea – Bruges
Reiland Isabelle - Attert
Roselle Benoit - Dinant
Rosiers Fanny - Gentbrugge
Sels Marc - Mechelen
Servais Gaëlle - Limal
Tambeu Jacques – Saint-Nicolas
Uwamahoro Linda - Huizingen
Vael Isabelle – Sint-Niklaas
Vandenbroecke Bart - Waasmunster

ANNEX 2

The following institutions and facilities cooperated by serving as a collection point for the biological samples collected in the framework of the health examination survey.

Collection point	Contact person
Somedi Labo, Heist-op-den-Berg	Gudrun Crabbe
COOP Pharmacy, Bruges	Joost Depreitere
OLV Hospital, Aalst	Peter Meeus
AZ Sint Blasius, Dendermonde	Rita Proft
De zwaantjes pharmacy, Zoersel	Ann Van Genechten
Maison Médicale Jean Jaurès, Schaarbeek	Fabian Baudry
General practice De Bron, Wolvertem	Christel Foriers
Labo LBS, Forest	Nathalie Pinto
CHU Charleroi – Hôpital Civil Marie Curie, Lodelinsart	Pascal Van Der Cruyssen
CHU Tivoli, La Louvière	Jonathan Brauner
Pharmacie Lefebure, Kain	Elodie Hardy
Laboratoire CHU UCL, Dinant	Nathalie Fonteyn
Clinique Vivalia d'Arlon	Nicolas Hougard
Synlab, Liège	Fabienne Poumay

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