AIR POLLUTION AND ITS HEALTH IMPACTS ON INTERNAL MIGRANTS IN BISHKEK, KYRGYZSTAN

ASSESSMENT REPORT

IOM UN MIGRATION

MOVE GREEN

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Survey data collector taking notes.
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ACRONYMS

COPD	chronic obstructive pulmonary disease
FGD	focus group discussion
IOM	International Organization for Migration
KII	key informant interview
MAC	maximum allowable concentration
MCS	mental component score
MTU	municipal territorial unit
NGO	non-governmental organization
PCS	physical component summary
PM10	inhalable particulate matter with diameters of 10 microns or less
PM2.5	fine particulate matter with diameters of 2.5 microns or less
SAEPF	(Kyrgyz) State Agency on Environment Protection and Forestry
SF-8	Eight-Item Short-form Health Questionnaire
TPP	thermal power plant
TROPOMI	Tropospheric Monitoring Instrument (onboard the Sentinel-5 Precursor satellite)
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNIDO	United Nations Industrial Development Organization
WHO	World Health Organization

Chemical formulas:

CH_2O	formaldehyde
CO	carbon monoxide
NH_3	ammonia
NO	nitrogen oxide
NO_2	nitrogen dioxide
SO_2	sulfur dioxide

Bishkek on the eve of a storm.
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EXECUTIVE SUMMARY

Air pollution in residential neighbourhoods on the outskirts of Bishkek, the capital city of Kyrgyzstan, is a public health emergency. Due to economic uncertainty, many households in these neighbourhoods rely on burning coal for indoor heat during the heating season (October to March). As a result, PM2.5 concentration in the air from mid-autumn to early spring can rise more than three times the norm. Since the early 1990s, many internal migrants from various regions of the country have been moving to Bishkek in search of better living conditions. As living in the city is not affordable for them, many of these internal migrants built their houses on the outskirts, where they are still inadequately connected to the city's public infrastructure.

This scoping study assesses the factors influencing air quality in the view of residents, including internal migrants living in the residential neighbourhoods, during the heating season and throughout the year, and the impacts of these factors on their health. The study looks at the 25 most polluted residential neighbourhoods with the largest number of migrants and the least access to infrastructure, public facilities and services. A mixed-methods approach is adopted and comprises an air quality map for the three heating seasons from 2019 to 2022, a household survey (*n*=615 participants, 30.9% women and 69.1% men), key informant interviews (*n*=50 participants) and focus group discussions (*n*=250 participants, 50% women and 50% men).

One of the study's limitations is that a part of the field phase coincided with the country's fourth wave of COVID-19, with some health indicators most likely having been influenced by the pandemic. Furthermore, there are no complete official statistical data on disease prevalence among internal migrants living in the studied residential neighbourhoods.

Survey respondents list the following among the factors that contribute to air pollution in the residential neighbourhoods: a lack of trash cans; irregular solid waste collection by the concerned municipal service; dust from heating with coal and unpaved roads; lack of air circulation; a high population density; and a lack of green spaces. The location of a residential neighbourhood also affects its air quality, with some areas situated near the thermal power plant, Dordoi Bazaar, the sanitary landfill, or one of the city's many factories. Residents living in the residential neighbourhoods face additional challenges, such as inadequate public services, including a lack of gas infrastructure and sewerage. Despite these challenges, most respondents do not want to move elsewhere and, in fact, are interested in investing in the houses they currently occupy (e.g. through home construction and improvements), as well as in their neighbourhoods.

Every third respondent reports having had such health symptoms as frequent headaches and/or dizziness, dry eyes, nose and/or throat, and allergies since moving to one of the residential neighbourhoods. In addition, every third respondent reported experiencing a variety of illnesses, including heart attacks, lung conditions, cancer and asthma. Some study participants expressed that they were experiencing lethargy, fatigue, emotional intemperance and nervousness in their behaviour, which they claim is due to poor air quality. Aside from the length of residency in the neighbourhoods, the type of fuel used for household heating and the location of the respondent's workplace may all have an impact on the health problems mentioned. One of the major challenges identified in households is that busy parents do not seek medical attention immediately when they or their children begin experiencing acute health symptoms. The lack of public hospitals and health facilities located nearby exacerbates this problem.

Coal is the most common fuel for households in the neighbourhoods. Most respondents find it expensive to switch to available alternatives such as gas and electricity. The home energy efficiency of most respondents remains unsatisfactory, with heat loss even in homes that have a heating method and/or equipment in place. Residents lack understanding of home energy efficiency and heat retention measures. If they had more information on the negative impacts of poor-quality coal, including the long-term health risks of using it, in addition to home insulation methods, residents would be more likely to switch from coal to cleaner forms of energy. Online resources, broadcast media, such as radio and television, and billboards are the most used and trusted information channels by the residents, including internal migrants. These can be used to educate about the negative impacts of coal, as well as providing information on home insulation methods.

To effectively address the problem of air pollution, the Bishkek City Mayor's Office and the Government of Kyrgyzstan are urged to develop a comprehensive plan of action that considers the communities of internal migrants living in residential neighbourhoods, civil society organizations, and small and medium sewing and bathhouse businesses located in these neighbourhoods. This report includes specific recommendations in relation to this issue.

Information session for residents conducted by IOM staff.
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INTRODUCTION

Air pollution is a pressing public health issue in big cities in Kyrgyzstan.[1] The capital, Bishkek, the largest hub for internal and international migrants, has repeatedly ranked among cities with the most polluted and hazardous air in the world in 2021.[2,3]

Urban air pollution is the leading cause of death from cardiovascular and respiratory diseases, including lung cancer.[4] High concentrations of particulate matter in the air can cause up to 3 per cent of deaths from cardiopulmonary disease and 5 per cent of deaths from lung cancer.[5] The elderly and the young, as well as persons with lung or heart conditions, are especially vulnerable. There is also growing evidence of the harmful effects of air pollution on other organ systems.[6] PM2.5 particles, which have a diameter of less than 2.5 μm and possess a mix of harmful physical and chemical characteristics, are especially dangerous, as they can enter not only the lungs but also the bloodstream, causing increased morbidity and mortality from various diseases.[7] Both short- and long-term exposure to high levels of PM2.5 particles in the air increases, for example, the risk of respiratory infections, including the novel coronavirus disease (COVID-19).[8] A study found that long-term exposure to polluted air increases mortality from COVID-19 by 11 per cent.[9] Another study, conducted by the United Nations Industrial Development Organization (UNIDO), reported that pollution was accountable for almost 14 per cent of all deaths in Kyrgyzstan in 2016.[10] The same report also highlighted that air pollution accounted for more than 80 per cent of the nearly 5,000 pollution-related deaths during that year.[11]

> *Internal migration movements can be temporary or permanent and include those [of people] who have been displaced from their habitual place of residence, such as internally displaced persons, as well as persons who decide to move to a new place, such as in the case of rural–urban migration. The term also covers both nationals and non-nationals moving within a [subnational] state if they move away from their place of habitual residence.*
>
> **IOM, *Glossary on Migration*, International Migration Law, No. 34**

1 UNIDO, Health and Pollution Action Plan: Kyrgyz Republic (Bishkek, 2019). Available at www.unido.org/sites/default/files/files/2019-10/Kyrgyzstan%20HPAP.English.pdf.
2 SAEPF and UNDP–UNEP Poverty and Environment Initiative in the Kyrgyz Republic, *The National Report on the State of the Environment of the Kyrgyz Republic 1997–2000* (Bishkek, SAEPF, UNDP and UNEP, 2001); SAEPF and UNDP–UNEP Poverty and Environment Initiative in the Kyrgyz Republic, *The National Report on the State of the Environment of the Kyrgyz Republic 2001–2003* (Bishkek, SAEPF, UNDP and UNEP, 2004); SAEPF and UNDP–UNEP Poverty and Environment Initiative in the Kyrgyz Republic, *The National Report on the State of the Environment of the Kyrgyz Republic 2006–2011* (Bishkek, SAEPF, UNDP and UNEP, 2012).
3 IQAir, *World Air Quality Report 2021* (Goldach, Switzerland, 2021). Available at www.iqair.com/world-air-quality-report.
4 WHO, "Ambient (outdoor) air quality and health", fact sheet, 22 September 2021. Available at www.who.int/news-room/fact-sheets/detail/ambient-(outdoor)-air-quality-and-health.
5 Ibid.
6 WHO, *WHO Global Air Quality Guidelines: Particulate Matter (PM2.5 and PM10), Ozone, Nitrogen Dioxide, Sulfur Dioxide and Carbon Monoxide: Executive Summary* (Geneva, 2021). Available at www.who.int/europe/publications/i/item/9789240034433.
7 WHO, "Ambient (outdoor) air quality and health" (see footnote 4).
8 WHO, "Health consequences of air pollution on populations", news article, 15 November 2019. Available at www.who.int/news/item/15-11-2019-what-are-health-consequences-of-air-pollution-on-populations.
9 Andrea Pozzer et al., "Regional and global contributions of air pollution to risk of death from COVID-19", *Cardiovascular Research*, 116(14):2247–2253 (December 2020). DOI:10.1093/cvr/cvaa288.
10 UNIDO, Health and Pollution Action Plan: Kyrgyz Republic (see footnote 1), p. 15.
11 Ibid.

Residential areas on the outskirts of Bishkek are the ones most affected by air pollution. These neighbourhoods, commonly referred collectively to as the "migration circle", were created by the influx of significant numbers of internal migrants from various regions of Kyrgyzstan in search of jobs and better social conditions. (IOM defines internal migration as "the movement of people within a State involving the establishment of a new, temporary or permanent residence".[12] Internal migrants make up 35 per cent of Bishkek's population[13].) While this so-called "migration circle" continues to grow, the residential neighbourhoods remain unregularized and unlinked to public amenities, including the city's heating and gas infrastructure.[14] There are signs of political will to regularize these residential neighbourhoods, with the President signing the Law "On Amendments to the Law of the Kyrgyz Republic" and "On the Transfer (Transformation) of Land" on 13 August 2021.[15]

As in Kyrgyzstan, many parts of the world are seeing migration from rural areas towards urban areas, where migrants are able to seek diverse opportunities and/or better access to essential services. However, cities can also be hotspots of risks, as many densely populated urban areas are exposed to air pollution, heatwaves, coastal erosion, drought and sea-level rise.[16]

The purpose of this scoping study is to understand the scale of air pollution in the residential neighbourhoods around Bishkek, and its impacts on the health and well-being of residents, including internal migrants. The study investigates the challenges faced by these residents and the level of awareness about the health-related risks of air pollution among them, as well as providing recommendations to improve air quality in the neighbourhoods.

12 IOM, *Glossary on Migration*, International Migration Law, No. 34 (Geneva, 2019).
13 IOM, *Internal Migration in Kyrgyzstan* (Bishkek, 2018). Available at https://kyrgyzstan.iom.int/sites/g/files/tmzbdl1321/files/documents/Internal%20Migration%20in%20Kyrgyzstan.pdf.
14 Office of the Ombudsman of the Kyrgyz Republic "Informal settlements of Bishkek: the right to adequate housing and other social, economic and cultural rights", special report of the Ombudsman of the Kyrgyz Republic (Bishkek, 2017).
15 Office of the President of the Kyrgyz Republic, "President of the Kyrgyz Republic on the Law on Amendments to the Law of the Kyrgyz Republic on the Transfer (Transformation) of Land", press release, 13 August 2021 (in Russian). Available at www.president.kg/ru/sobytiya/20312_podpisan_zakon_kirgizskoy_respubliki_o_vnesenii_izmeneniy_v_zakon_kirgizskoy_respubliki_o_perevode_transformacii_zemelnih_uchastkov.
16 IOM, *World Migration Report 2022* (Geneva, 2021).

BACKGROUND OF THE STUDY

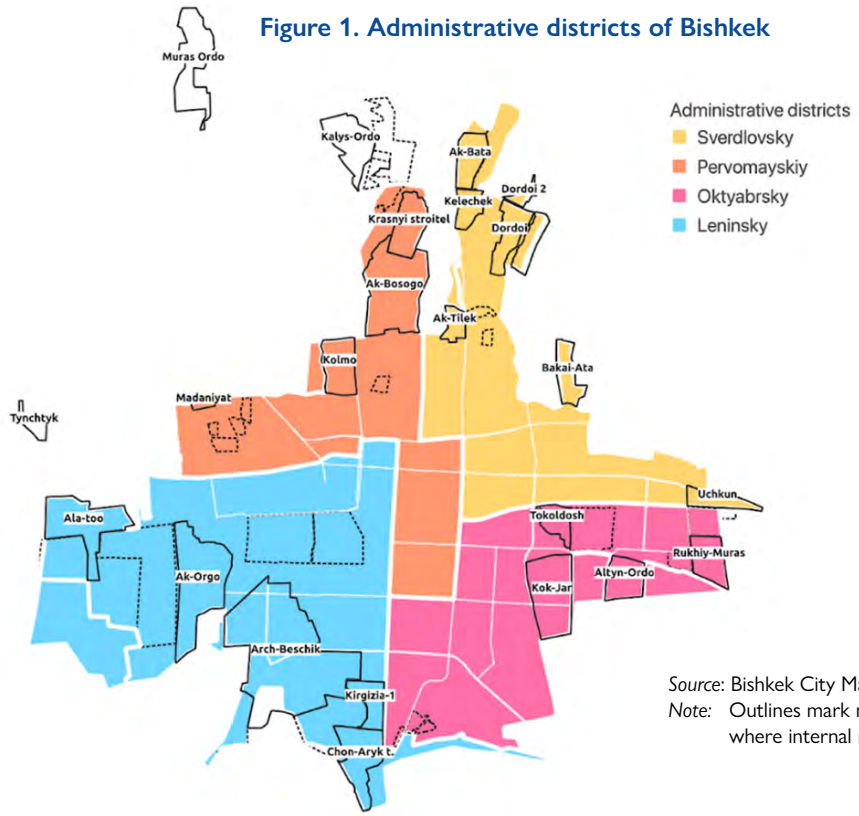
Bishkek is located in a mountain valley where air pollutants often tend to get trapped in certain areas due to the air current patterns and the nature of the terrain itself, especially during the winter. The ongoing construction of tall buildings across the city does not always take into account the city's general plan (layout, topography and infrastructure) and wind circulation.[17] In addition, Bishkek's sanitary landfill, where waste burns all year long, also exacerbates air pollution.

Air pollutants such as NO, NO_2, and CH_2O remain high throughout the year, exceeding the maximum allowable concentration (MAC).[18] Outdated vehicles are a major cause of these pollutants.[19] As of December 2020, more than 400,000 private vehicles were registered in Bishkek, and around 2,000 minibuses circulate through the city every day.[20] Heavy traffic is concentrated in the city centre. Most vehicles in the city use low-environmental-class diesel fuel.

Reduced green spaces in Bishkek, the use of a salt-and-sand mixture to prevent ice forming in the winter, dust due to the lack of asphalt paving on roads in residential neighbourhoods around Bishkek, soil from building sites, and particle build-up on the tyres of large vehicles coming from quarries also contribute to ambient air pollution. The main source of air pollution in the winter is the use of low-quality coal in Bishkek's thermal power plant (TPP) and by the residential neighbourhoods surrounding the city.[21]

Bishkek is divided into four administrative districts: Sverdlovsky, Oktyabrsky, Leninsky and Pervomayskiy (Figure 1). The city has 47 residential neighbourhoods in total: 17 in Pervomayskiy District, 14 in Sverdlovsky, 11 in Leninsky and 5 in Oktyabrsky.

Figure 1. Administrative districts of Bishkek



Source: Bishkek City Mayor's Office.
Note: Outlines mark neighbourhoods (47 in total) where internal migrants reside.

17 *24.KG*, "Smog in Bishkek: The Bishkek city council recalled the wind rose", 26 November 2018 (in Russian). Available at https://24.kg/vlast/102276_smog_vbishkeke_vbishkekskom_gorodskom_keneshe_vspomnili_oroze_vetrov/.

18 SAEPF and the UNDP–UNEP, *NRSE 1997–2000*, *NRSE 2001–2003* and *NRSE 2006–2011* (see footnote 2).

19 Regional Environmental Centre for Central Asia (CAREC), the Environmental Agency of Austria (EAA) and Zoï Environment Network (ZEN), *The State of the Environment in Central Asia: Illustrations of Selected Environmental Themes and Indicators* (Almaty, CAREC; Vienna, EAA; Geneva, Zoï Environment Network; Astana, Forest Law Enforcement and Governance and Ecosystem Restoration in Central Asia (FLERMONECA), 2015). Available at https://wedocs.unep.org/20.500.11822/7561.

20 World Bank, "Transport data readiness assessment: The Kyrgyz Republic", report, December 2017 (Almaty). Available at https://documents1.worldbank.org/curated/en/361071593441075181/text/Transport-Data-Readiness-Assessment-The-Kyrgyz-Republic.txt.

21 O.A. Podrezov, A.O. Podrezov and V.E. Riazanov, "Bishkek City atmospheric air pollution in the winter season of 2017–2018", *Vestnik KRSU*, 18(12).

Pervomaykiy District comprises around 13,000 households.[22] Only 15 per cent of these households have access to gas heating, with most of the population using coal.[23]

Sverdlovsky District has almost 9,000 households,[24] with only 14 per cent being connected to the gas heating infrastructure.[25] Air pollution levels are as high as in Pervomayskiy District.

Oktyabrsky District has about 7,000 households,[26] with 30 per cent connected to gas heating.[27] This may be one of the reasons for the lower PM2.5 concentrations during the heating season in the district compared to Pervomayskiy and Sverdlovsky.

Leninsky District consists of aproximately 15,000 households,[28] 58 per cent of which are connected to the gas heating infrastructure.[29]

The peripheral areas of Bishkek to the north and north-west, as well as parts of areas to the west and north-east, have the highest PM2.5 concentrations.[30] These include the residential neighbourhoods of Kolmo, Muras-Ordo, Altyn-Beshik, Enesay, Kalys-Ordo, Bakai-Ata, Tynchtyk, Ak-Bosogo and Dordoi. These neighbourhoods are in a geographic trough, with air pollutants trapped in cold air underneath a layer of warmer air (temperature inversion). The eastern and southern peripheral parts of Bishkek have less air pollution due to their low population density and better air circulation.[31]

In addition, high levels of PM2.5 are associated with a high number of residential neighbourhoods in an administrative district with households that are not connected to gas heating.

The Hydrometeorological Service of Kyrgyzstan (i.e. the State Agency on Hydrometeorology), or HydroMet, provides data on nine major air pollutants that are harmful to human health (NO, NO_2, CH_2O, SO_2, NH_3, PM10, PM2.5, PM1 and total suspended particulate). The monitoring conducted by HydroMet, however, does not cover the residential neighbourhoods around the city. As part of the current study, data recorded by air pollution sensors installed by the non-governmental organization (NGO) MoveGreen in 2019 to detect PM2.5 in some of these communities will help to better understand air pollution trends.

22 Correspondence from the Bishkek City Mayor's Office dated 13 July 2021.
23 Ibid.
24 Ibid.
25 Ibid.
26 Ibid.
27 Ibid.
28 Ibid.
29 Ibid.
30 Data from HydroMet and MoveGreen's air quality sensors (recorded in 2019–2022).
31 Ibid.

METHODOLOGY

Study design

The study utilized a mixed-methods approach consisting of an air quality map, a household survey, key informant interviews (KIIs), and focus group discussions (FGDs). Also undertaken was a desk review of documents (from 1997 to 2022) available online, including on official government websites, as well as in international and NGO publications, on the causes or sources of urban air pollution in Bishkek, and the impacts of this pollution on migration and health.

Study setting

The 25 most polluted new settlements with the highest numbers of migrants and the least access to infrastructure, public amenities and services were identified using the following data (which relate to geographic and infrastructural factors), as well as available health data:

(a) MoveGreen's air quality map showing the most polluted areas for two (out of three) heating seasons;
(b) HydroMet data on elevation and wind direction;
(c) Municipal government data on residential neighbourhoods' population size (including number of migrants);
(d) Municipal government data on residential neighbourhoods' access to gas infrastructure;
(e) Ministry of Health data on the number of hospitals and/or health centres per residential neighbourhood.

Air quality maps

Air quality maps were developed based on measurements of PM2.5 pollution collected through 25 air quality monitoring sensors installed by HydroMet and MoveGreen during the period covering September 2019 to March 2022.

The TROPOspheric Monitoring Instrument (TROPOMI) onboard the Sentinel-5 Precursor satellite, launched in October 2017 by the European Space Agency, was used to map and analyse two additional air pollutants, NO_2 and CO, from November to December 2020.

Household survey

A household survey was conducted, data derived from which were triangulated with data from the qualitative tools. A total of 615 households across 25 residential neighbourhoods around Bishkek were interviewed from 4 February to 13 March 2022. The head or the most informed[32] member of the household was chosen as the respondent. Based on Bishkek's 2021 population data, the city's total population was 35,969.[33] The study's sample size, with a confidence level set at 95 per cent and a margin of error at four per cent, was calculated using the formula below:

$$n = \frac{\frac{z^2 p(1-p)}{e^2}}{1 + \left[\frac{z^2 p(1-p)}{e^2 N}\right]}$$

32 That is, the member of the household who has the most knowledge about the household.
33 Correspondence from the Bishkek City Mayor's Office dated 13 July 2021.

where:

- n is the sample size.
- p is the sample proportion (in this case, p=0.5).
- z is the z-score (at a 95% confidence level, z=1.96).
- e is the margin of error (in this case, e=0.04).
- N is the total number of households.

A structured household survey tool was developed to collect data in the following areas: (a) sociodemographic profile of the household head (or the most informed household member), including age and education, as well as household size; (b) family migration history; (c) household financial situation; (d) health condition/status of family members; (e) access to heating infrastructure ; (f) household heating, if any; (g) home energy efficiency; and (h) most used channels for receiving information. The survey included such questions as the following as proxy indicators for internal or international migration:

(a) Which *oblast* (province) are you originally from?
(b) How many years ago did you move to this residential neighbourhood?
(c) Where did your family live before moving to this residential neighbourhood?

To capture survey respondents' general physical and mental health profiles, the "8-Item Short-form Health Survey" (SF-8) was used – a short version of the "36-Item Short-Form Health Survey" (SF-36) tool that is widely used to monitor health outcomes and assess health-related quality of life. SF-8 uses single-item scales that assess the following domains: (a) general health; (b) physical functioning; (c) role limitations due to physical health problems; (d) bodily pain; (e) "vitality" (i.e. pertaining to issues of energy and fatigue); (f) social functioning; (g) mental health; and (h) role limitations due to emotional problems. Each domain is rated on a scale of 100, where 100 = "excellent" and 0 = "very poor". The tool was used for comparative analyses and to find out what factors, according to residents, can affect the mental and physical health of residents.

A team of 15 interviewers, trained prior to the data collection stage, with one supervisor – all of whom could speak Kyrgyz and Russian – conducted the surveys. A pilot survey of 10 households was undertaken from 10 to 15 January 2022.

Key informant interviews

The KII guide included separate questions on air pollution and health, and on measures to improve air quality. The purpose of the KIIs was to obtain information, insights and recommendations from experts of different backgrounds: community leaders, government officials (e.g. from the municipal territorial units (MTUs), the Bishkek City Mayor's Office, the Ministry of Health of Kyrgyzstan and the Ministry of Natural Resources, and Ecology and Technical Supervision of Kyrgyzstan), representatives of public associations and international organizations, and academics.

A total of 50 KIIs were conducted by a trained interviewer from 8 February to 13 March 2022: 10 with the heads of MTUs; 16 with medical doctors serving in the residential neighbourhoods; and 24 with representatives from the Bishkek City Mayor's Office, and the community of experts knowledgeable about air quality in Bishkek. The KIIs with the MTU representatives lasted about 30 minutes; with the doctors, about 20 minutes; and those with the air quality experts, up to 50 minutes. Three pilot KIIs were conducted with medical doctors from 9 to 15 December 2021 to finalize the quantitative and qualitative instruments.

Focus group discussions

To complement the survey findings on air pollution and its impacts, 25 FGDs were organized in the residential neighbourhoods from 8 February to 13 March 2022. A total of 250 FGD participants (50% women and 50% men), with each focus group having 10–12 participants, were selected based on whether they resided in one of the target localities, represented a local women's council, were members of a court of elders (*aksakaly*), or were community superintendents. FGDs were based on a short list of questions designed to elicit detailed information, as well as the views and perceptions of migrants as "insiders" living in the residential neighbourhoods. Discussions lasted for up to one and a half hours.

During each FGD, moderators asked participants to draw a map of their community on a flipchart that indicated all available infrastructure, including the common types of houses, common spaces, business establishments and other notable places present therein. The participants also reflected on practices and activities that affected air quality in their residential neighbourhood. Five pilot FGDs were conducted from 9 to 15 December 2021 to finalize the quantitative and qualitative instruments.

Ethics

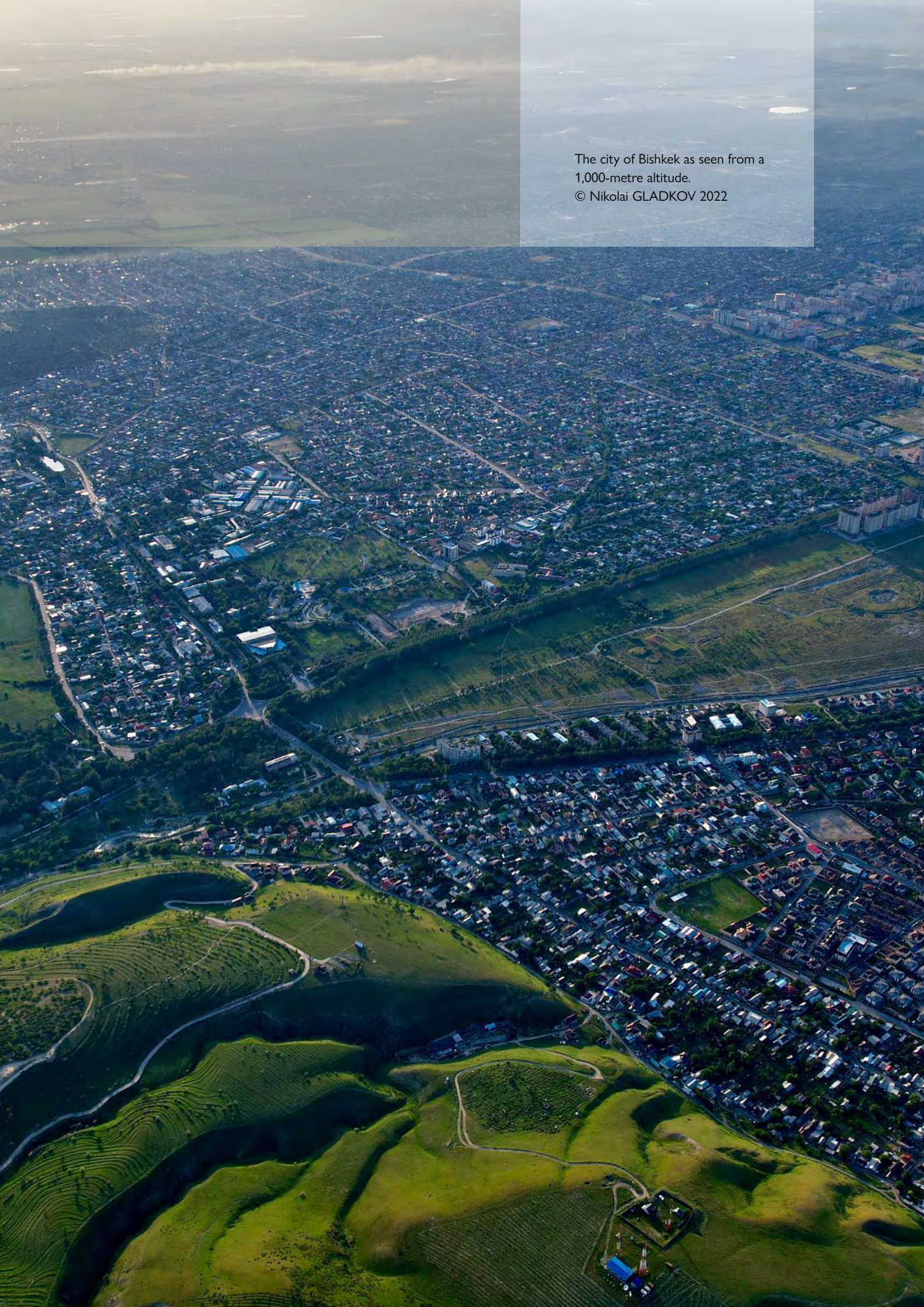
Participation in the study was voluntary, and participants could withdraw at any time. All details, including the goal of the study, were thoroughly explained to the respondents prior to the household survey, FGDs and KIIs, and written consent forms were signed. Audio recordings, for quality control, were kept on a password-protected server, to which a limited number of data controllers had access. Personal data was never shared with third parties.

Data analysis

FGDs and KIIs were conducted, recorded and transcribed in full in Kyrgyz and Russian. The research team applied an inductive approach and used the criteria of frequent occurrence, intensity, and significance to analyse KII and FGD findings.

The quantitative variables of the household survey were tabulated and analysed using the Statistical Package for the Social Sciences (SPSS), version 21. The SF-8 physical and mental health summary scores (i.e. the physical component score (PCS) and mental component score (MCS)) were calculated and summarized (e.g. means and standard deviation). The internal consistency and reliability of the SF-8 questionnaire was evaluated using the appropriate Cronbach's alpha coefficient for each domain and the overall questionnaire (a Cronbach's alpha coefficient of 0.7 was considered acceptable).[34] Multivariate analysis of variance (MANOVA) was used to determine the influence of sex, age and financial situation on the household survey respondents' overall physical and mental health. The PCS and MCS scores from the SF-8 health status measure served as the outcome measures.

34 Ann Bowling and Shah Ebrahim, *Handbook of Health Research Methods: Investigation, Measurement and Analysis* (first edition, Maidenhead, United Kingdom, Open University Press).



The city of Bishkek as seen from a 1,000-metre altitude.
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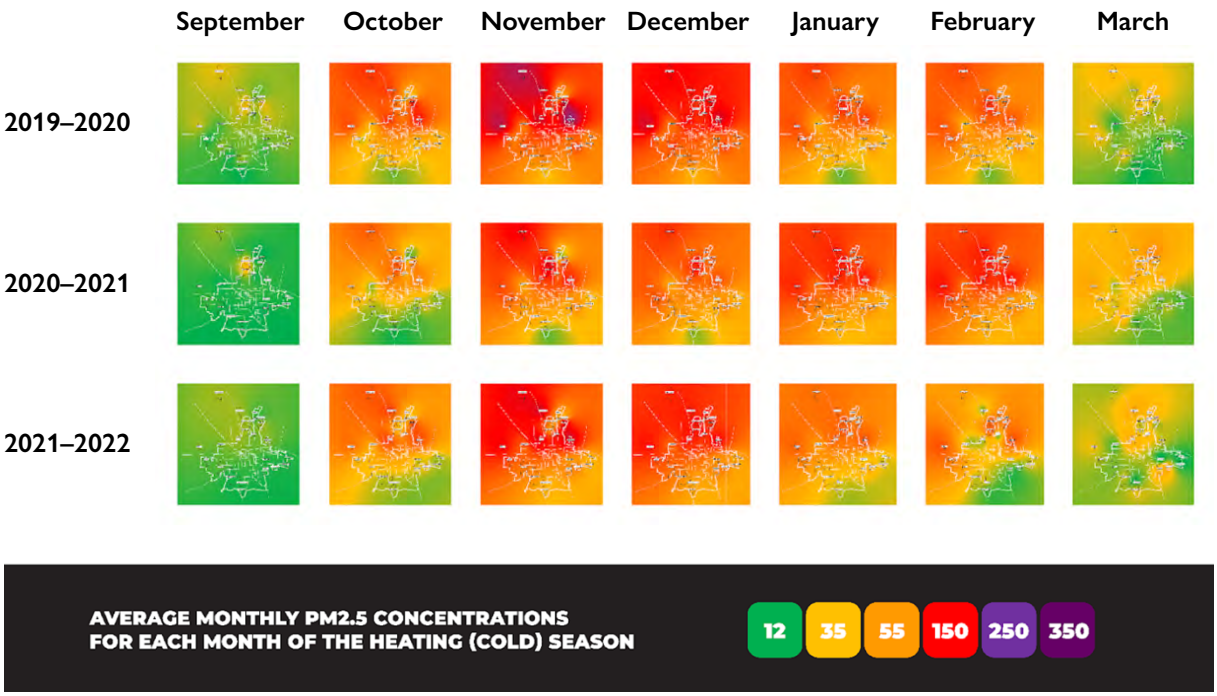
RESULTS AND FINDINGS

Air quality maps

Input data for air quality maps of three heating seasons (2019–2020, 2020–2021 and 2021–2022) were obtained from HydroMet. PM2.5 data was collected from 25 air quality monitoring sensors from September 2019 through to March 2022. Each sensor was located in one of the target residential neighbourhoods surrounding the city. The air quality maps are shown in Figure 2.

Figure 2. Air quality maps of Bishkek covering three heating seasons (2019–2022)



The locations of the sensors are marked on the maps as polygons with the names of the residential neighbourhoods. Colours on the maps show air quality, with the colour gradient ranging from green to deep purple.

Green and yellow mean that air quality is good and moderate, respectively. Within this range, PM2.5 concentrations do not exceed the MAC (i.e. 35 μg/m^3). Orange (PM2.5 concentration is within the range of 35–55 μg/m^3) indicates that air quality is harmful for people with heart or lung disease (e.g. asthma), children and teenagers, people who are active outdoors, and the elderly. Red (PM2.5 levels within the 55–150 μg/m^3 range) corresponds to air that is unhealthy for all. Light and deep purple (PM2.5 levels within the 150–350 μg/m^3 range) mean that the air is not only unhealthy, but hazardous.

As the maps show, levels of PM2.5 air pollution in Bishkek and the surrounding residential neighbourhoods in September (across all three heating seasons) remain within the 13–20 μg/m^3 range, well below the MAC. In some neighbourhoods located relatively far from the city centre or in the vicinity of the city's landfill, the pollution levels are at 32 μg/m^3. These are the neighbourhoods of Kolmo, Muras-Ordo, Altyn-Beshik, Enesay, Kalys-Ordo, Bakai-Ata, Tynchtyk, Ak-Bosogo and Dordoi, and considered having the highest levels of air pollution.

With the beginning of the heating season in October, PM2.5 levels rise sharply, averaging from 46–69 μg/m^3 (1.5–2 times the norm) and reaching a maximum of 125 μg/m^3 (3.5 times the norm) in some of the neighbourhoods. Such pollution levels are extremely harmful to children, the elderly and people with health conditions.

November and December are the coldest months of the year. It is also when levels of particulate matter pollution are at their highest. The average concentration of PM2.5 ranges from 75–117 μg/m^3 (2.1–3.3 times the norm), with maximum average values of up to 220 μg/m^3 (6.3 times the norm). These high levels of air pollution are very harmful to everyone.

In January and February, PM2.5 levels are, on average, 2–2.6 times the norm, with a range of 69–91 μg/m^3 and reaching maximum values of up to 139 μg/m^3 (four times the norm) in the residential neighbourhoods with the highest levels of pollution. Such high concentrations of pollution are harmful to children, the elderly and people with health conditions.

In March, with its relatively warm weather marking the end of the heating season, PM2.5 levels drop to 28–37 μg/m^3 (more or less within the normal range), reaching 39–56 μg/m^3 in the neighbourhoods (1.1–1.6 times the norm). These levels of air pollution are acceptable.

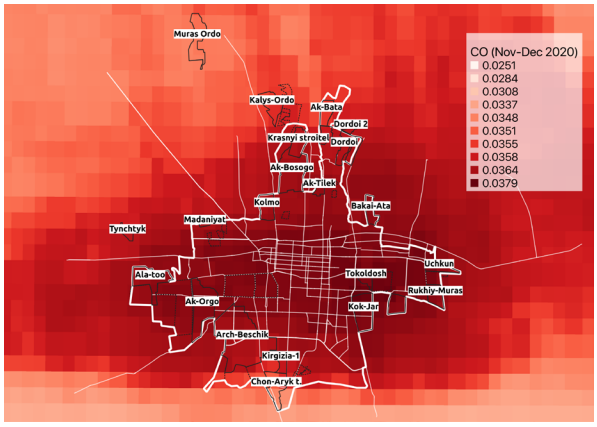
At the onset of each of the last three heating seasons (2019–2020, 2020–2021 and 2021–2022), concentrations of PM2.5 air pollution in Bishkek and the surrounding residential neighbourhoods increased dramatically from insignificant to levels that are harmful to human health. Thus, in winter, the average PM2.5 pollution concentration is 2–3.3 times the norm (i.e. 69–117 μg/m^3). In some areas and during the coldest months, levels shoot up to 4–6.3 times the norm (i.e. up to 220 μg/m^3). With the end of the heating season, levels of air pollution in both Bishkek and the surrounding residential neighbourhoods drop again to insignificant levels.

The main sources of PM2.5 particulate pollution during the heating season include waste from the burning of low-quality coal, waste by-products from other heating sources, waste from the sewing industry and the burning of car tyres. An additional source of pollution is the Bishkek landfill, which burns regardless of weather conditions.

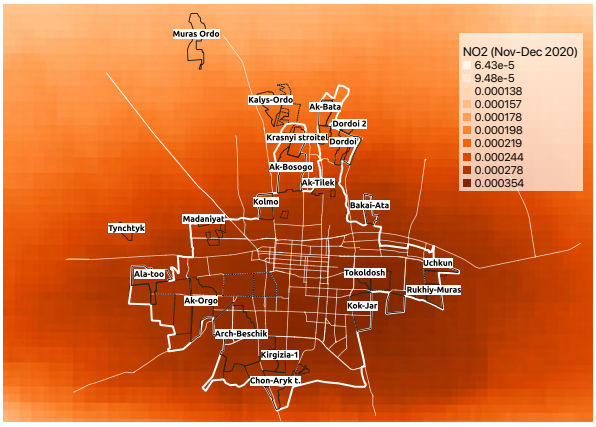
In addition to particulate matter, open data from TROPOMI, on the Sentinel-5 Precursor satellite, shows levels of NO_2 and CO pollution during the coldest months (November–December 2020) of the 2020–2021 heating season (Figure 3).

Figure 3. Pollution in Bishkek, November–December 2020

(a) CO, mol/m^2



(b) NO_2, mol/m^2



As stated in the "Background" section, the primary sources of NO_2 and CO emissions are vehicles that use low-environmental-class diesel fuel. Thus, the highest concentrations of these air pollutants in the troposphere are observed over the central parts of the city, owing to the heavy traffic of both private and public transport vehicles, the latter being the main means of urban transportation – both in the city and on its outskirts, where the studied residential communities are located. The landfill also contributes to the increase in pollution by these gases.

The map in Figure 3a shows that CO concentrations are higher in residential areas of the city such as Kyzyl-Asker, Pishpek, Rabochiy Gorodok, the area along Mederov Street, the area south of the Great Chuy Canal, and the city centre, where the highest CO concentrations (0.0364–0.0379 mol/m^2) are recorded.

Elevated CO concentrations of up to 0.0364 mol/m^2 are also observed in the neighbourhoods around Bishkek targeted by the study, especially those located in the immediate vicinity of the city's landfill.

Figure 3b shows that NO_2 concentrations are high up to 0.000278 mol/m^2 over the central district, in the boundary between Chuy Avenue and Tokombayev Street, and from Ibraimov Street (Zhukeyev–Pudovkin Street) to Tynaliyev Street. This is due to high traffic volumes, network congestion and bottlenecks, which, when combined with the widespread use of low-quality fuel, results in increased emissions of hazardous compounds in the atmosphere.

Household survey respondents' demographic profile

Figure 4 shows the distribution of respondents by residential neighbourhood. Most of the household survey participants were residing in the Archa-Beshik, Kok-Jar, Ak-Bosogo and Ak-Orgo at the time of the survey.

Figure 4. Percentage distribution of households by residential neighbourhood

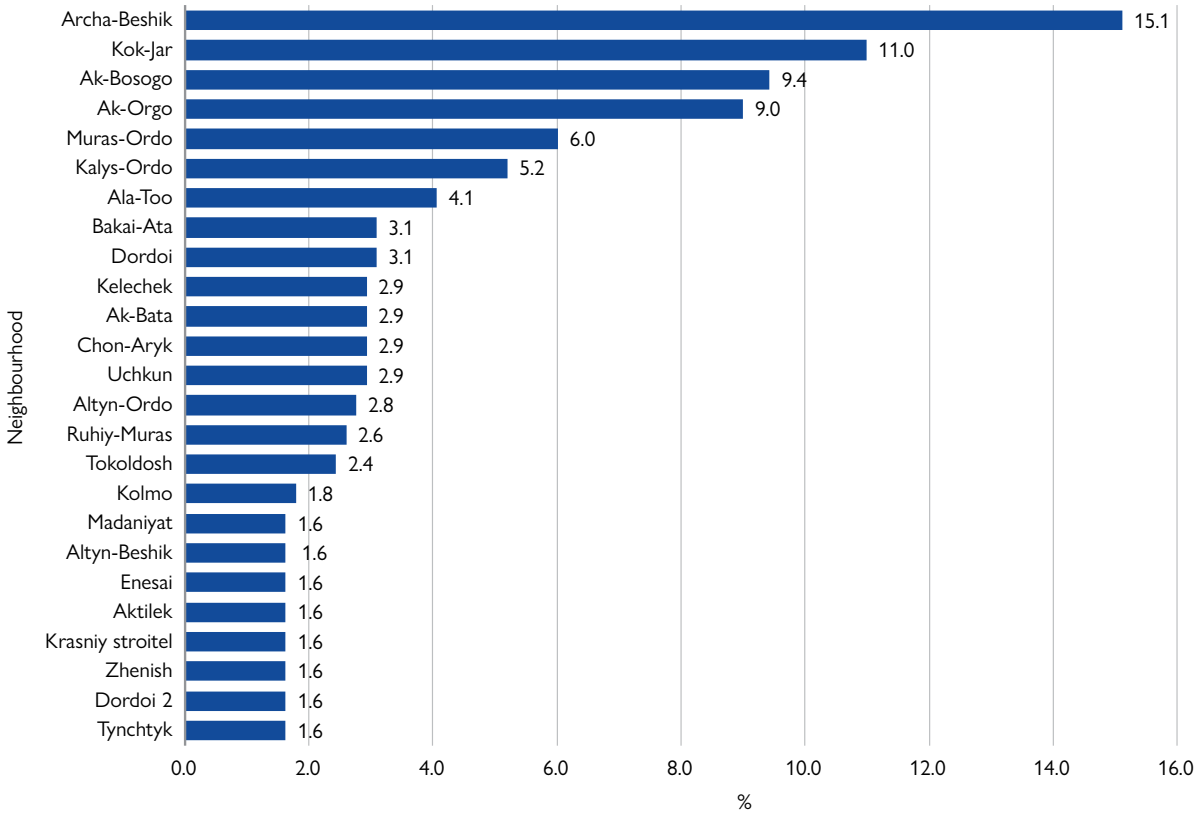
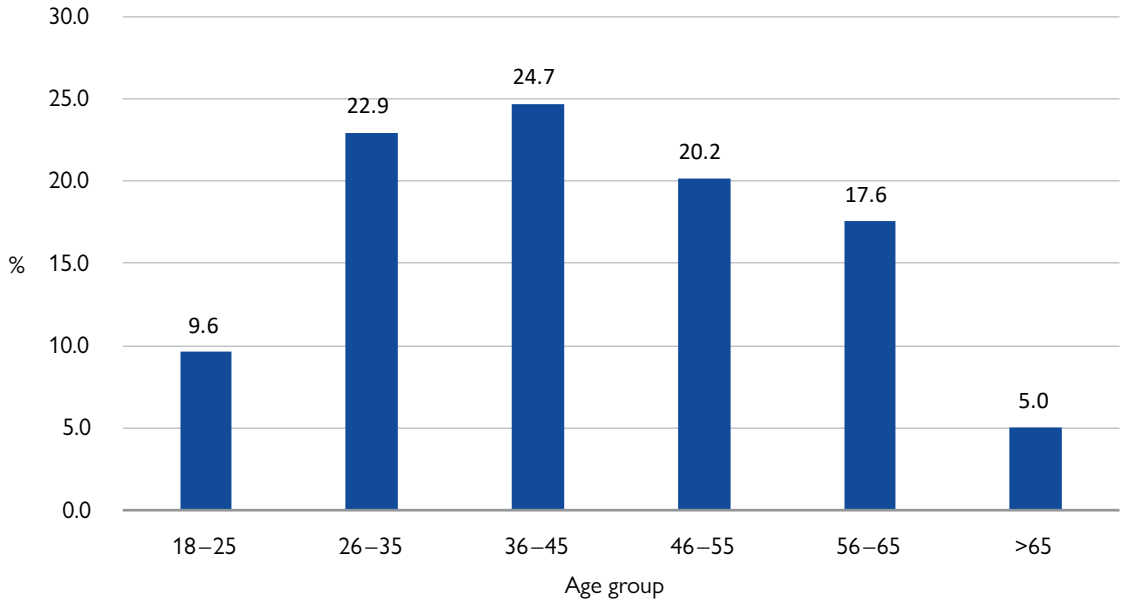


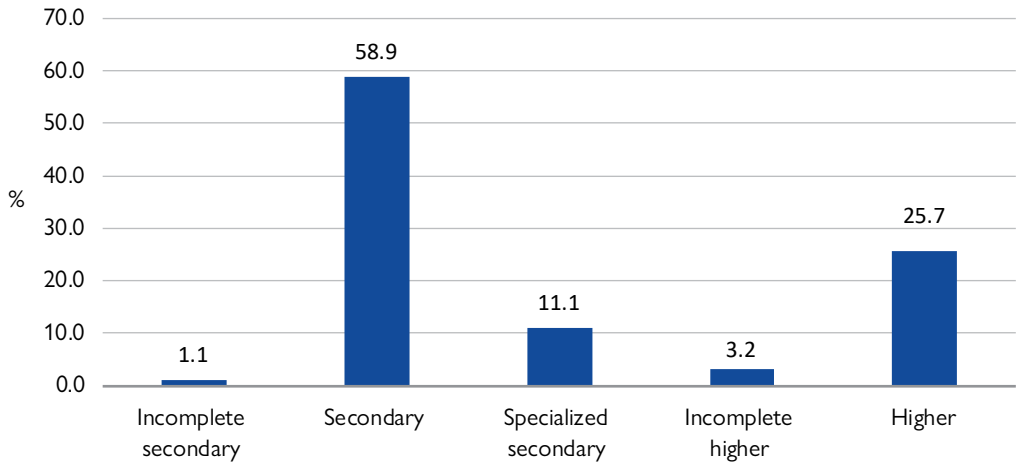
Figure 5. Percentage distribution of respondents by age



Of the survey's 615 respondents (representing one household each), 69.1 per cent are men and 30.9 per cent are women. The main share of respondents consists of the adult, working-age population (Figure 5). In terms of ethnicity, 96.7 per cent of the respondents are Kyrgyz; 1.3 per cent, Russian; 1 per cent, Uighur; 0.4 per cent, Uzbek; and the remaining 0.6 per cent are represented by various other nationalities, which include Kazakhs, Germans and Tatars.

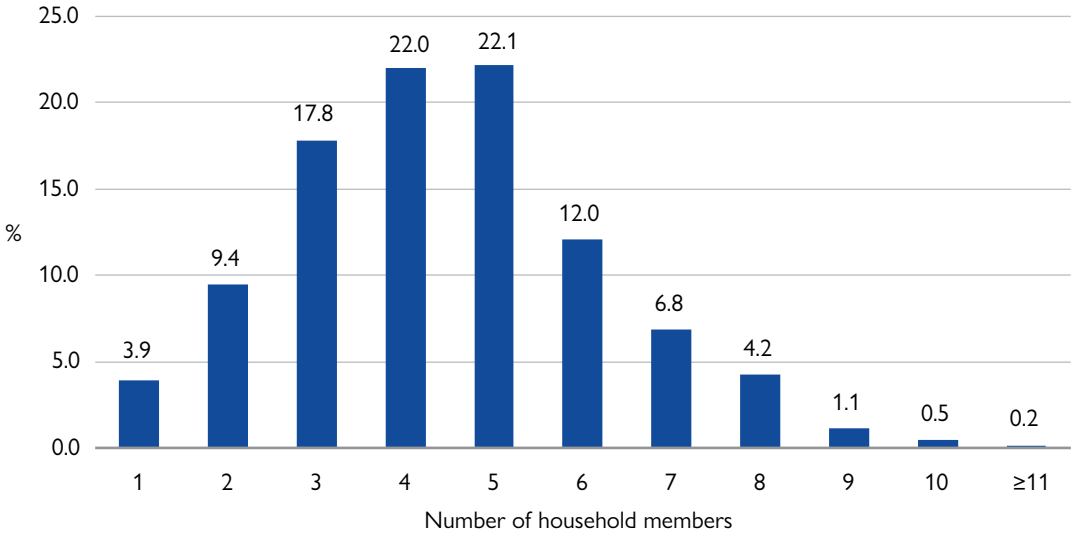
Most respondents have some secondary education, with most of them having at least some secondary education (Figure 6).

Figure 6. Percentage distribution of respondents by education level



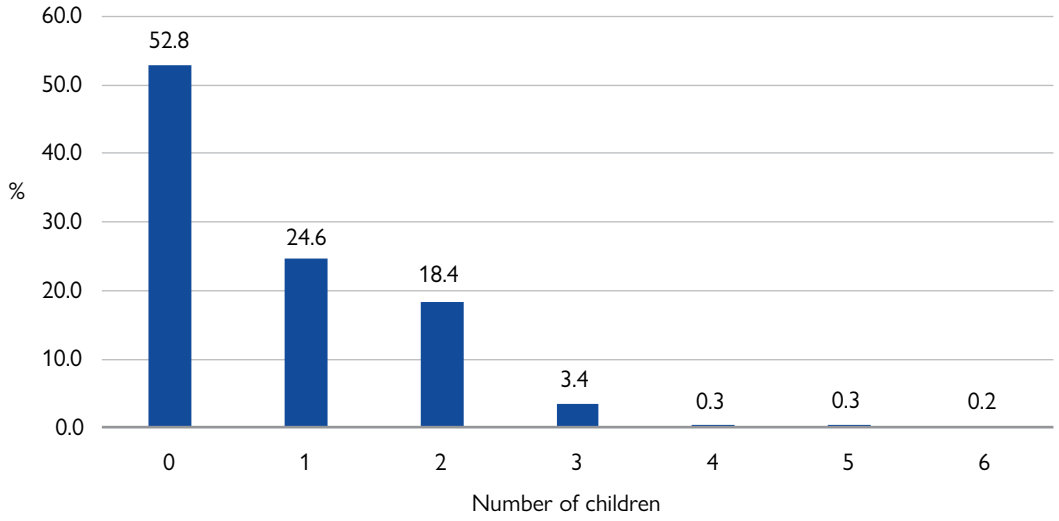
Almost 79.6 per cent of respondents are married; 10.1 per cent are single; 5.4 per cent are widowed; and another 4.9 per cent are divorced. At the same time, Figure 7 shows that most of the households in the studied residential neighbourhoods have large families.

Figure 7. Percentage distribution of households by number of household members



Almost every second surveyed household (47.2%) has small children (Figure 8), aged 0 to 5, who are among the most vulnerable to air pollution.

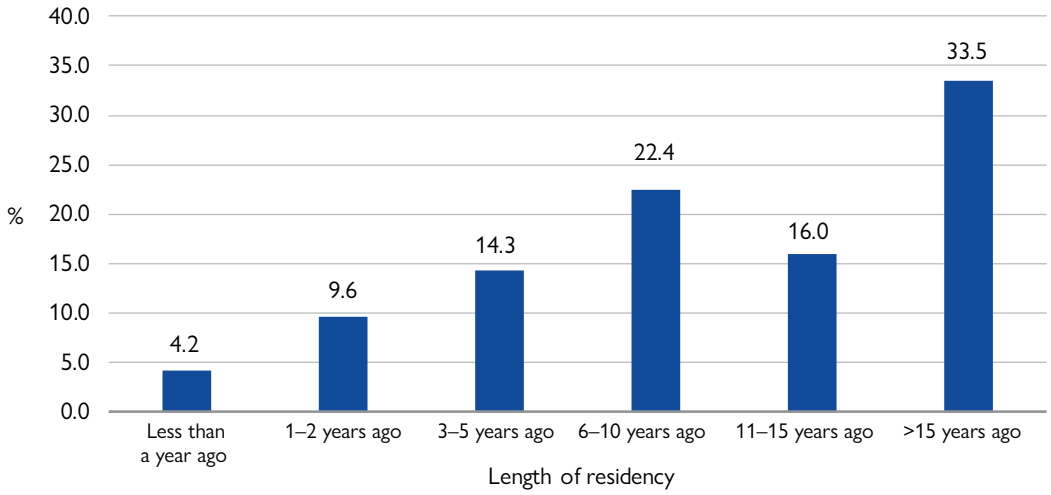
Figure 8. Percentage distribution of households by number of children in the 0–5 age range



Migration status

Every third respondent (33.5%) moved to their current residential neighourhood more than 16 years prior to the study (Figure 9). The overwhelming majority (99%) of the respondents are internal migrants, with the remaining 1 per cent coming from Tajikistan, Kazakhstan and the Russian Federation.

Figure 9. Percentage distribution of households by length of residency in their current residential neighbourhood

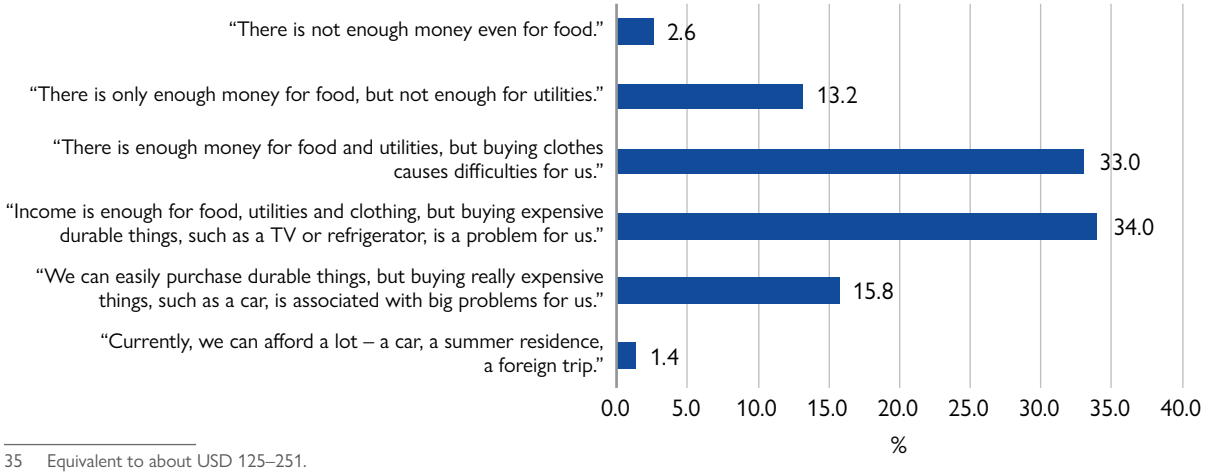


The largest group (25%) of surveyed internal migrants moved to their current residential neighbourhoods from Naryn Region. Almost every sixth respondent moved from Issyk-Kul Region, while the smallest percentage came from Osh City (citizens of the southern regions tend to migrate to other countries for work).

Household socioeconomic status

The average total household income of the respondents is quite low. The combined monthly income of all household members in every third household ranges from KGZ 10,000–20,000,[35] with 12.2 per cent and 13.7 per cent earning KGZ 20,001–25,000 a month[36] and less than KGZ 10,000 a month,[37] respectively. More than half of the respondents live below the poverty line,[38] a situation that significantly determines their lifestyle and the type of household heating and home construction that they could afford.

Figure 10. Respondents' assessment of their household financial situation



35 Equivalent to about USD 125–251.
36 Equivalent to about USD 251–314.
37 Equivalent to about USD 125.
38 Some 25.3 per cent of the population were on or below the poverty line in 2020, based on data from the National Statistical Committee.

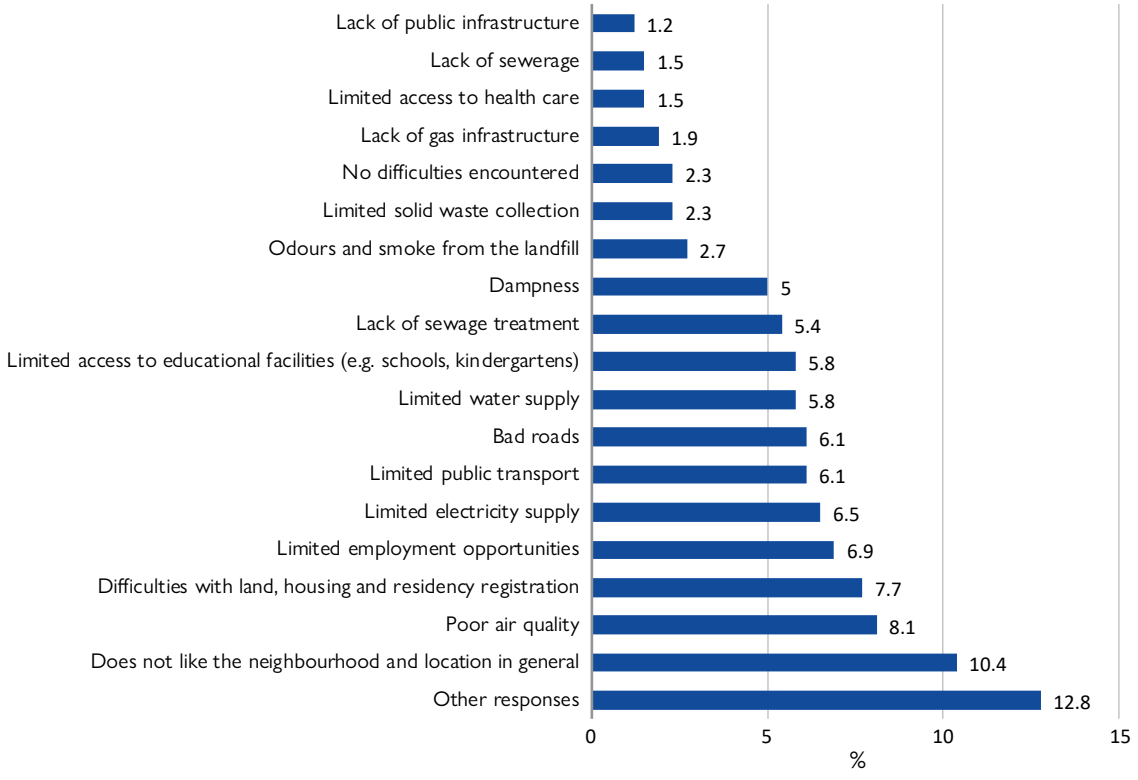
Street art in the residential neighbourhood reads in the Kyrgyz language: "#we need a park". © IOM 2022/Elnura DJOLDOSHEVA

The perception that the households are of generally low financial situation was corroborated during the FGDs and by key informants. Every third surveyed household in the target residential neighbourhoods does not have enough money for food and utilities (Figure 10). Another 13.2 per cent have money for food, but not enough for utilities.

With regard to home ownership, 46.4 per cent of the respondents own the homes they reside in (as opposed to being mere tenants); 29.4 per cent live in homes owned by their parents; and 24.2 per cent are tenants. Tenant respondents are generally less interested than homeowner respondents in developing their residential neighbourhoods and improving the houses they live in – likely because tenants are not legally required to make improvements to their dwellings. In addition, the National Government, MTUs and the Bishkek City Mayor's Office are the ones responsible for improving infrastructure in the city and its residential outskirts. This is different from the general picture presented by key informants, who stated that most of these residents are not homeowners but tenants who are not interested in the betterment of their surroundings or in the development of their own places of residence.

In 59.5 per cent of the surveyed households, each household member has a residence permit and registration in their respective MTUs. On the other hand, 30.3 per cent of the surveyed households have no members who are registered residents. Another 8.1 per cent note that only some of their household members have residence permits. In the remaining 2.1 per cent of the households, either only the respondent has a residence permit or the respondent is unable to provide information on the matter.

Figure 11. Challenges of living in the studied residential neighbourhoods



Children playing on the lonely iron swings in the residential neighbourhood. © Askat CHYNALY

The survey shows that families in the targeted residential neighbourhoods face many problems and challenges – the poor location of the neighbourhoods being the most commonly reported by respondents. The neighbourhoods are far from the city centre, and public transport connections between them are limited. Every tenth respondent describes their neighbourhood as "unsatisfactory" (e.g. because it is near the city's landfill). Poor air quality is reported by 8.1 per cent of respondents. A small number of respondents (5–7.7%) note difficulties in obtaining official documents of land ownership and residency registration, limited employment opportunities, lack of electricity, limited public transport connections, bad roads, lack of water, poor infrastructure, and the dampness of the ground and the air.

Respondents note the presence of various odours and smog, irregular solid waste collection (household and industrial), and the lack of gas heating infrastructure and sewerage, among others, as less significant problems. They also voice out the poor quality of the soil itself in the neighbourhoods, poor-quality flooring in residential premises and houses, expensive heating systems, dust in the air, and the lack of voltage in sockets, as well as the lack of playgrounds and irrigation systems.

Despite the existing hardships, there is a significant feeling of place attachment observed among the surveyed residents. The highest number of respondents who plan to stay in their current residential neighbourhood is recorded in Enesai (90% of respondents), Uchkun (88.9%), Archa-Beshik (80.6%), Tokoldosh (80%), Muras-Ordo (75.7%), Ak-Bosogo (72.4%), Chon-Aryk, Kelechek and Ak-Bata (72.2% each), as well as Aktilek (70%). On the other hand, the largest proportion of those wishing to move out of their neighbourhood is recorded in Kolmo, at 72.7 per cent, much higher than the average of 23.5 per cent in most other neighbourhoods.

At the same time, more than half of the surveyed households struggle to make the bare minimum to purchase food, pay utility bills and afford other essentials (Figure 10). Respondents confirm that there are a number of problems, such as limited public services, affecting the comfort of living in the residential neighbourhoods and must be addressed. Nevertheless, most respondents do not want to move out, which may imply an interest in participating in the development of their respective neighbourhoods.

Heating in the residential neighbourhoods

This section examines the household heating methods and equipment used by residents in the studied neighbourhoods.

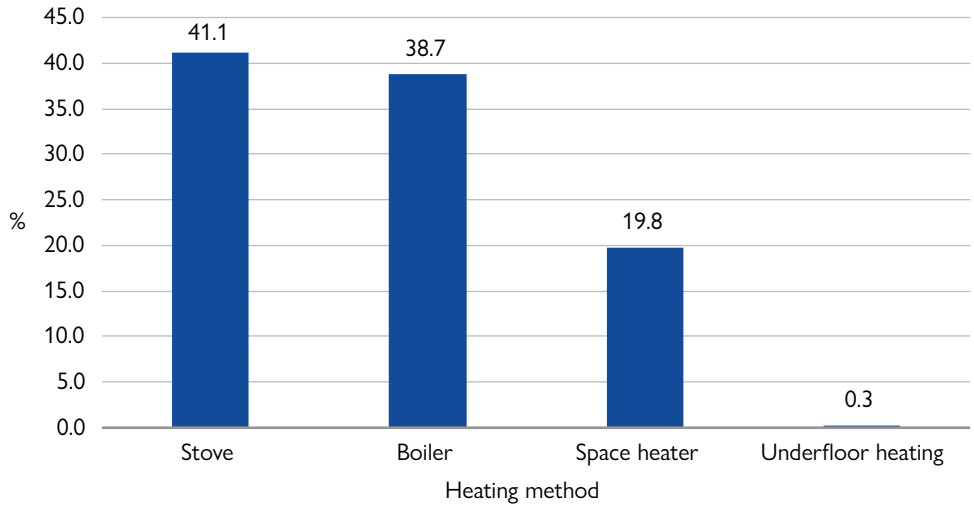
Stoves are the most popular option, followed by boilers and, to a much lesser extent, space heaters (Figure 12). Households with an average monthly income greater than KGZ 40,000 tend to use stoves more than households with lower incomes. Around half (50%) of households with higher incomes heat their houses using boilers.

Burning coal is the most popular means to heat homes, as there is limited gas infrastructure, including pipes. In addition, gas can be more expensive than coal. The largest share (28.6%) of households that use gas for heating earn more than an average of KGZ 40,000 a month. Only 7 to 22 per cent of respondents whose household monthly income is less than KGZ 40,000 use gas.

When I was young, I used to use "Bakai-Ata coal". I used this coal because I did not know that this coal was of poor quality. Now I always buy "Kara-Keche coal" because I think about the health of my family. I try to plant seedlings and plants in my plot and make the area greener. I also do community service. Our air quality is so bad that when we hang laundry, it turns black, so we hang our laundry inside the house. I go out of the house in the morning and look at the pipes from the residents' stoves, and in some of them, the gases that come out of the pipes are black, some are blue – which indicates that all the residents are heating with different solid waste[s].

Pensioner resident, Bakai-Ata residential area

Figure 12. Percentage distribution of households by heating method or equipment used



Our residential area has recently been supplied with gas, and if at least 70 to 80 per cent of residents [would] switch to gas, then the air would be a little cleaner, because they [residents] will stop heating with coal, wood and rags. Now about 10 per cent of the residents use only gas heating. This year, the cost of gas has increased, and gas heating costs about KGZ 10,000 to KGZ 15,000 per month. Because of unemployment, few can pay such money, and some have even stopped using it [gas]. In any case, if 70 to 80 per cent of the population use gas, the air will be cleaner.

MTU Chairman, Ala-Too residential neighbourhood

Most residents are aware that they use poor-quality coal – that is, coal that burns quickly, leaving behind a lot of ash, harmful emissions and, sometimes, even radioactive substances. Some residents have observed a significant deterioration in their health due to the use of low-quality coal and have switched to more expensive coal – to the detriment of the family budget.

The use of electricity for heating by respondent households remain limited due to three main reasons. First, electricity costs much more than coal. Furthermore, the Government introduced restrictions on the use of electricity during the last autumn–winter heating season due to the decreasing volume of water in hydropower reservoirs. To be specific, residents were not allowed to use appliances with wattages of more than 5 kilowatts. There have been cases of appliances being sealed by municipal authorities and lights turned off when the energy consumption limit was reached. Finally, there are frequent blackouts in the residential neighbourhoods – thus, electricity remains an unreliable source for heating. Two thirds of the surveyed households state that 1 to 4 tons of coal is adequate for them for one heating season. (Figure 13).

Figure 13. Percentage distribution of households by quantity of coal required for one heating season

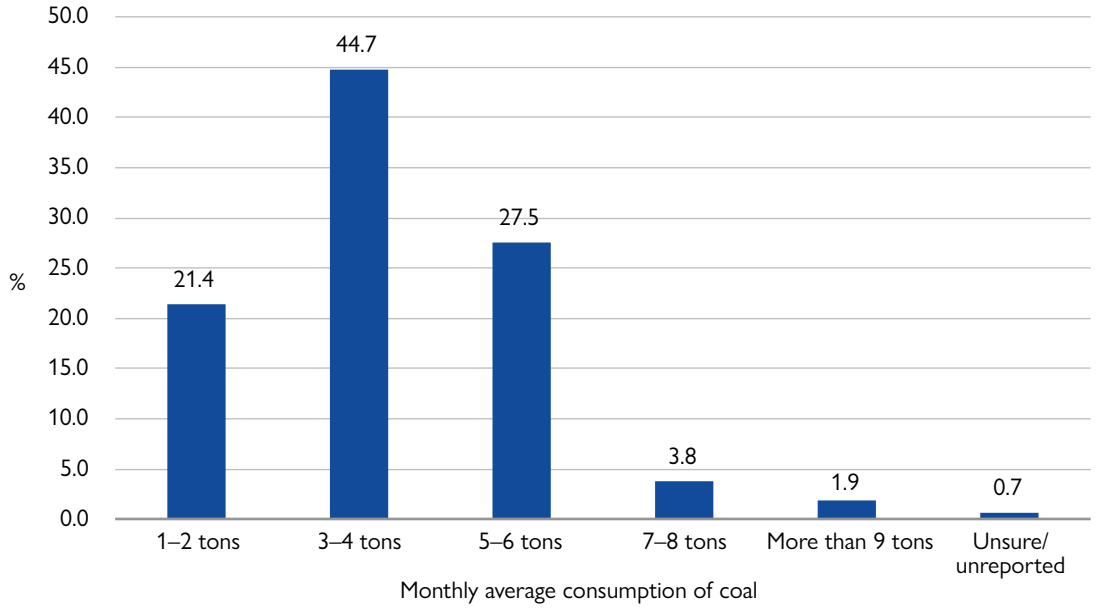
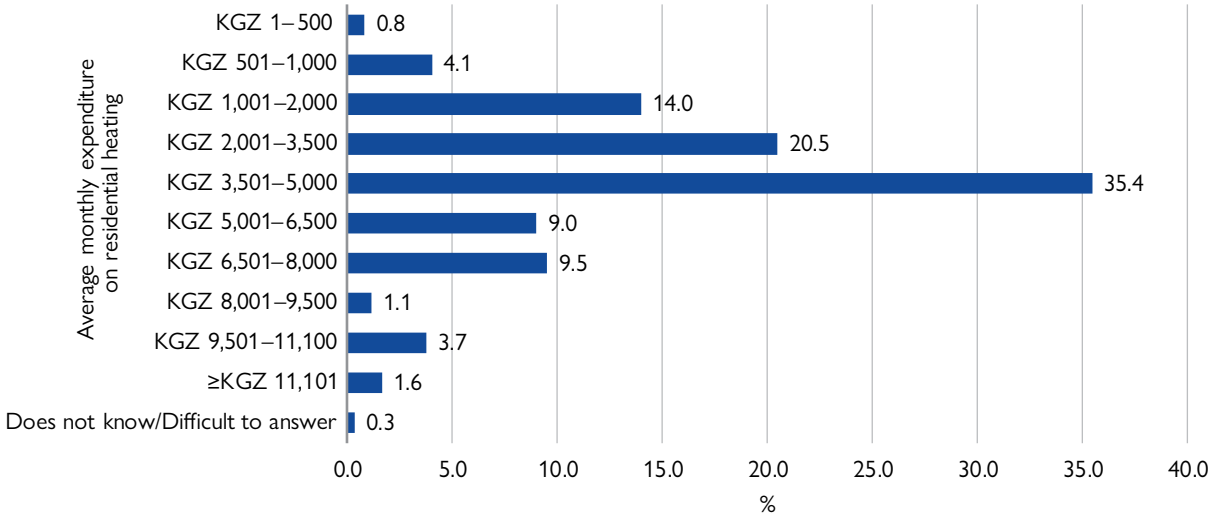


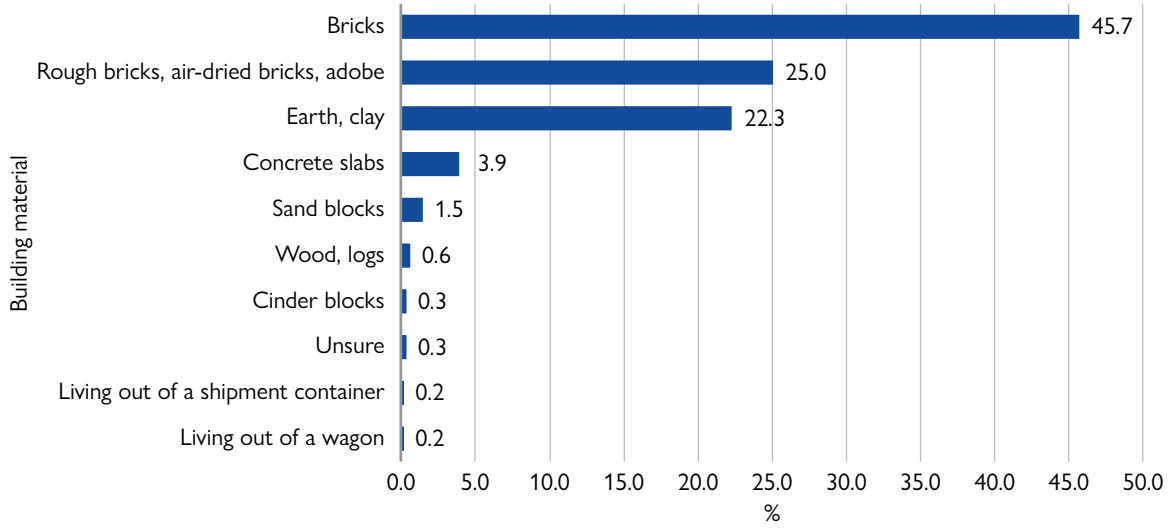
Figure 14 shows the percentage distribution of households by average monthly expenditure on residential heating during the heating season. With 53.3 per cent of respondent households having a monthly total income in the KGZ 5,000–25,000 range, 47.7 per cent note that current heating costs are too high for them.

Figure 14. Percentage distribution of households by average monthly expenditure on residential heating during the heating season



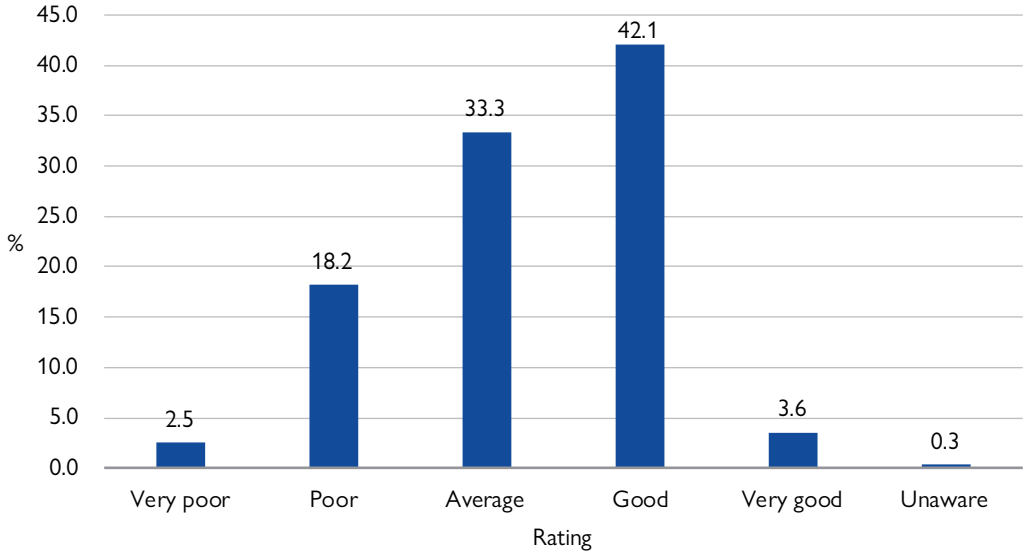
The energy efficiency of a home plays a role in retaining heat and economizing the amount of energy it uses – and, therefore, the money spent on it. The homes of nearly half (45.7%) of the respondents from the residential neighbourhoods are built of bricks (Figure 15), which are good for keeping homes cool during the warm months but not for keeping them warm during the cold months.

Figure 15. Percentage distribution of households by building material used in their homes



Asked to rate the efficiency of their houses at retaining heat, 42.1 per cent of the respondents report it to be at a "good" level. Every third respondent gives an "average" rating for their house, and 20.6 per cent rate it as either "bad" or "very bad" (Figure 16).

Figure 16. Respondents' rating of their homes' heat retention efficiency



The FGDs and the KII reveal several key reasons why the respondents' homes have low energy efficiency. Building energy-efficient housing is expensive, and most residents have low incomes. Homeowners may not be interested in investing in energy-efficient home features (e.g. to prevent heat loss), since they build houses to be rented out (i.e. they do not plan to live in them). Similarly, tenants lack interest in investing in the improvement of homes that do not belong to them. In addition, residents may not be aware of the potential sources or causes of heat loss in the first place, or of available technologies for making homes energy-efficient.

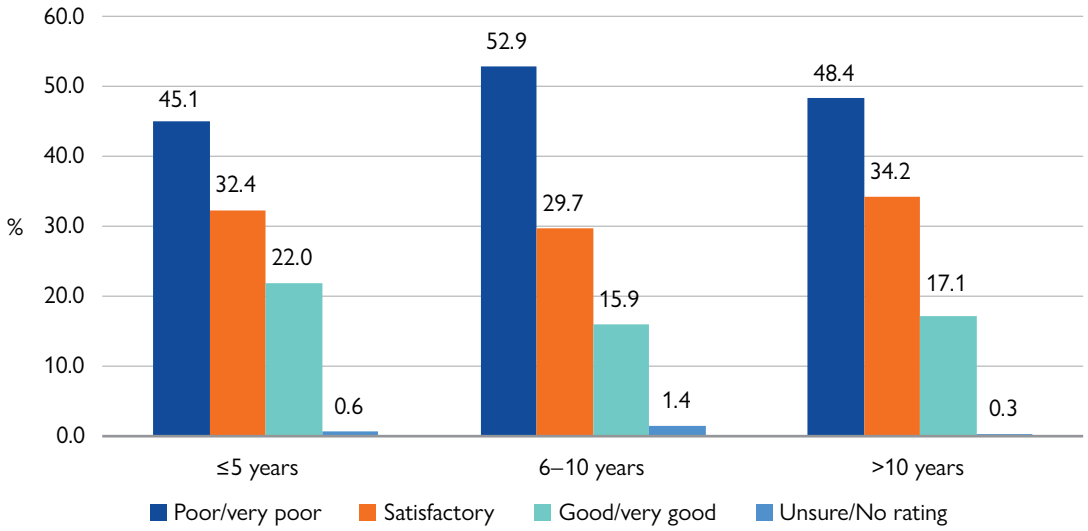
> *There is a lot of temporary construction, and the owners do not necessarily live there – these are houses built in haste, which are then rented out. Neither the owner nor the tenant is interested in investing…to install a more modern stove, heated with gas. Also, I do not think gas heating will solve the problem. Why? Gas equipment is very expensive. I myself am a resident [here] and I know what gas heating is. This is when gas burners are built into a coal stove. Thousands of soms are spent on this heating [system]. I do not think that many can afford a modern gas boiler. Many residents will try [it] for two months, and then they see that it is very expensive, and again start using coal.*
>
> **Expert, Archa Initiative**

Burning coal is still the most common way to heat homes during the autumn–winter heating season, and transitioning to other available heating methods would be costly for most households. Moreover, the energy efficiency of most homes remains unsatisfactory – which is why they still lose a lot of heat regardless of the heating method or equipment used by residents.

Survey respondents' perceptions of factors affecting air quality

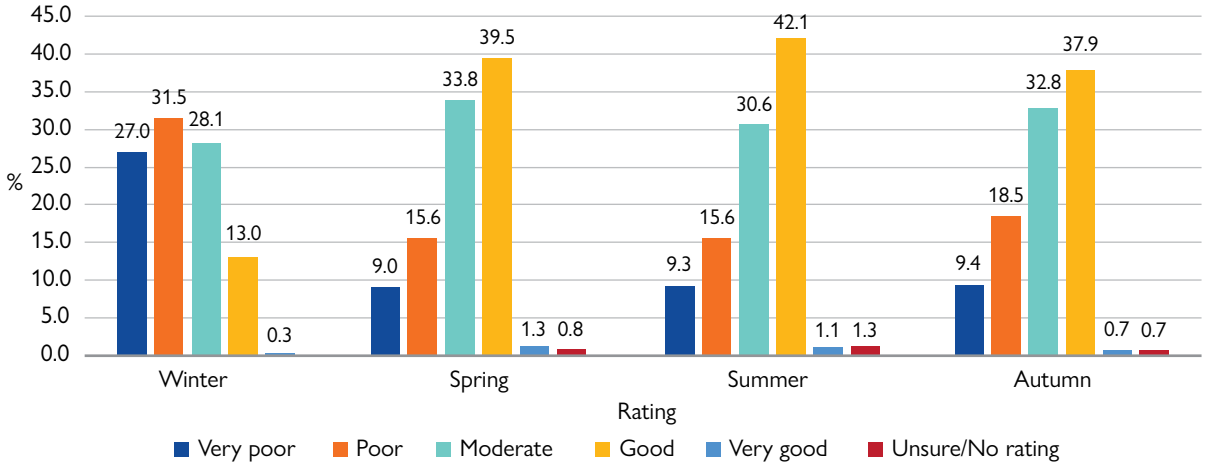
Most survey respondents rate the air quality in their neighbourhoods as either "poor" or "very poor". This is especially apparent among respondents that have been residents of their current neighbourhoods for the past 6 to 10 years (Figure 17).

Figure 17. Respondents' ratings of their neighbourhoods' air quality



Most of the respondents also indicated that air quality worsens during the winter (Figure 18). Respondents perceive that air quality is considerably good in the spring, summer and autumn.

Figure 18. Respondents' ratings of their neighbourhoods' air quality, by season



FGD and KII participants also note seasonal changes in air quality, which deteriorates especially in the winter:

> "It is hard to breathe in the winter."
> "I have a constant cough in the winter."
> "In winter, the children do not even want to go outside to play."
> "When I return from work, I do not even see houses when I walk down the street in wintertime."

At the same time, some FGD and KII participants are convinced that poor air quality in the studied residential neighbourhoods is observed all year round due to poorly developed infrastructure in these areas, which lack green spaces, playgrounds and other public amenities. As there are practically no asphalt roads, dust rises in the air all the time. In addition, the neighbourhoods are located adjacent to "unfavourable" zones such as the TPP, Dordoi Bazaar, the city's landfill and various factories. In autumn, it is common to see residents burning dry leaves, as these are not included in garbage collection, nor are there facilities in the neighbourhoods for their proper disposal. In addition, municipal services impose fines on those who accumulate them on their property. To avoid this fine, residents burn dry leaves gathered from around their property, even as the act of burning leaves comes with its own fine. They believe that they have no other option but to burn the leaves, as they are unaware or uninformed that the fumes released are harmful to the environment and their own health and/or that they can bury the dry leaves in their backyard as a way of disposing them.

> *In the residential areas, air quality is poor not only during winter due to the heating of stoves, but also in the spring, because then the ground becomes very dry and all this dust blows in the air, as there are a lot of unpaved roads. In the summer, air quality is poor due to the heat and the dusty air, and because there are no green spaces. And in the autumn, the air is bad because the residents burn leaves, as there is nowhere to dispose of them. I think these are the most socially vulnerable areas in the city, especially the lower and western residential areas. When it is hot in the city, it is insanely hot in the residential areas; when the air is bad in the city, it is very bad in the residential areas. Therefore, we can say that these are people living with high environmental risks.*
>
> **Expert, Archa Initiative**

Factors that respondents think might have the most negative impacts on air quality are:

(a) Lack of trash bins in the neighbourhoods (100% of respondents);
(b) Dust from stoves (80%);
(c) High population density of the neighbourhoods (75.6%);
(d) Dust from unpaved roads (74.5%);
(e) Lack of green spaces (70.2%).

In addition, respondents enumerate the city's landfill (52.8%), dust from highways (37.6%), factories (36.9%), ongoing construction work (33.5%) and the TPP (30.2%) as the primary causes of air pollution. The presence of these factors, except for the TPP, can be considered unique to specific residential neighbourhoods, since not all of them are located near the landfill or the TPP.

At the same time, FGD respondents and key informants note that the constantly growing number of residents has led to chaotic construction activity, which blocks natural ventilation in the neighbourhoods, and an increase in the number of vehicles – thus, more heat is produced from these areas. However, public infrastructure is not being developed to keep pace with population growth.

Residents of the Bakai-Ata residential neighbourhood, located next to the TPP, suffer from air pollution all year round, unlike residents of the other neighbourhoods and the City of Bishkek. The latter feel the effects of pollution from the TPP generally only during the winter. This pollution originates from ash dumps that accumulate at the TPP in the summer and get blown to the neighbourhood all year round. According to key informants, the storage of ash at the TPP violates existing standards and regulations. To rectify this, permission could be obtained to inspect the TPP and see how the stored ash is managed. In the summer, Bakai-Ata residents could taste the ash in the air even when the TPP is not running. The residents claim that pollution from the TPP was worse in the 1990s and has slightly improved in recent years with the installation of a new chimney, with new filters. Many of the respondents mention that the air in the city has always been dirty, with significant deterioration over the past three years. It was then that the public began to raise matters with authorities and actively discuss specific issues that had not been observed before.

Here one cannot speak from out of the blue. One must rely on data. But I think that this problem has always existed. This problem existed even in Soviet times. My grandmother lived in Chon-Aryk. And I remember, when you climb the mountains [nearby], you would always see a "black city" – that is, air pollution has always been there, [even] in Soviet times. Now there is a public outcry about this problem, so we began to pay attention to it. And, secondly, [the problem has gotten worse] as more and more people come to the city and there is more new construction.

Expert, Archa Initiative

Each ash dump at the TPP is the size of a football field, and there are about 14–15 of them – a very large area! When one dump is full, it is covered with earth. Then this process continues, and this soil is blown away.

FGD participant, Bakai-Ata residential neighbourhood

Self-rated health status and health symptoms of the respondents

Internal consistency of the SF-8 Health Survey

The mean SF-8 domain scores, ranging from 50.73 to 86.05, and their standard deviations are presented in Table 1. Mean PCS score is 72.5 and the mean MCS score is 76.7. Cronbach's alpha coefficient exceeds 0.80 when any of the items is removed (range: 0.81–0.84), indicating good internal consistency of the SF-8 instrument. The standard deviations (Table 1) show a large variability in the data. A more detailed picture is shown in Figure 19.

Table 1. Reliability, main trends and variability in the SF-8 domains

Item	SF-8 domain	Mean[a] (SD)[b]	Cronbach's alpha[c]
1	General health	50.73 (19.35)	0.84
2	Physical functioning	79.39 (27.97)	0.82
3	Physical role	79.06 (28.95)	0.81
4	Bodily pain	80.84 (27.92)	0.82
5	Vitality	56.26 (21.85	0.83
6	Social functioning	85.32 (26.29)	0.83
7	Emotional role	79.18 (28.31)	0.83
8	Mental health	86.05 (23.56)	0.82
	Overall PCS[d]	72.50 (26.05)	0.82
	Overall MCS[e]	76.70 (25.09)	0.83

Note: a Mean scores
b Average standard deviation
c Cronbach's alpha computed by removing the items from SF-8 one by one
d PCS score (general health, physical functioning, and physical or bodily pain)
e MCS score (vitality, social functioning, and emotional and mental health)

Physical and mental health profile of respondents

Comparing the physical and mental health of respondents across the target residential neighbourhoods, Kolmo (PCS = 57.72; MCS = 65.81) and Jenish (PCS = 62.5; MCS = 62.8) indicate the worst health outcomes, while Archa-Beshik (PCS = 80.2; MCS = 83.55) and Muras-Ordo (PCS = 79.1; MCS = 83.16) show the best results.

Figure 19. Physical and mental health indicators by residential area

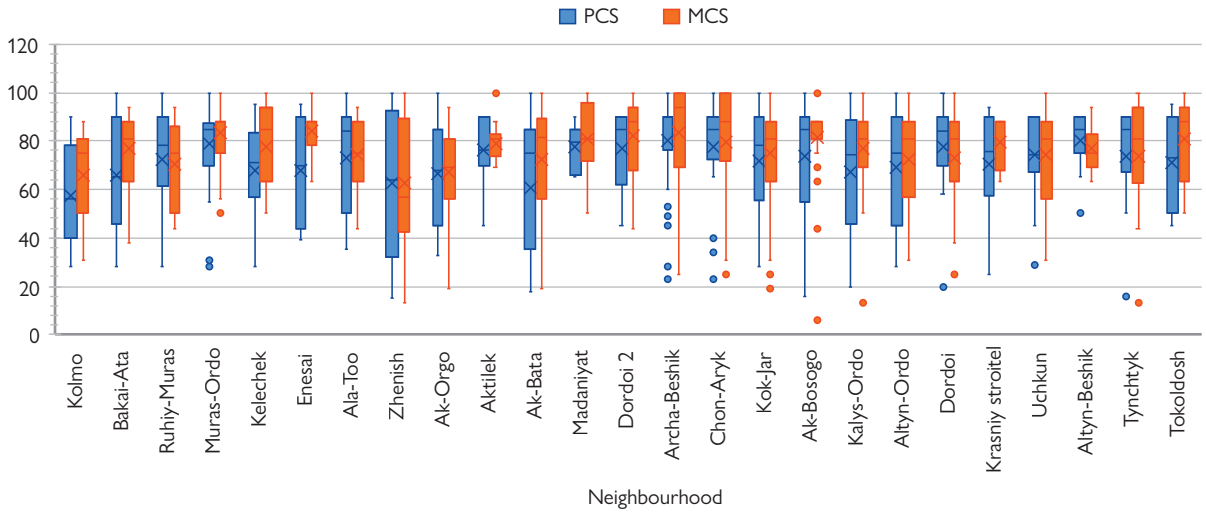
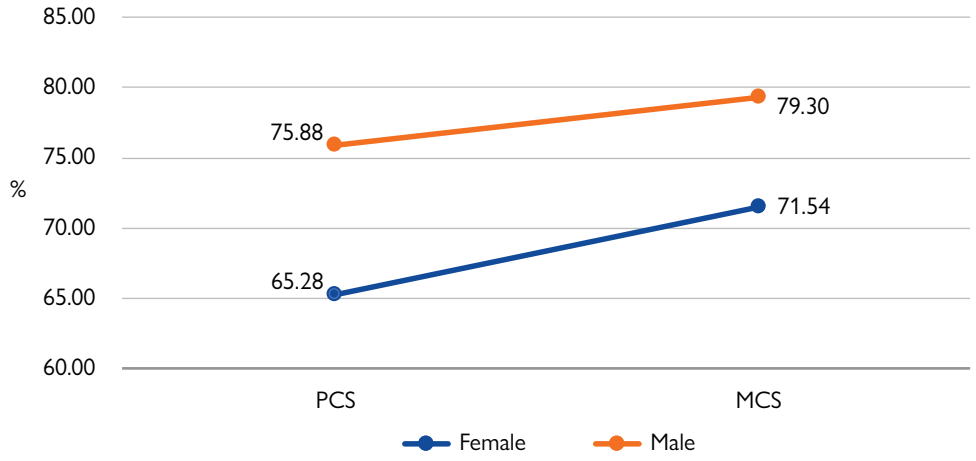
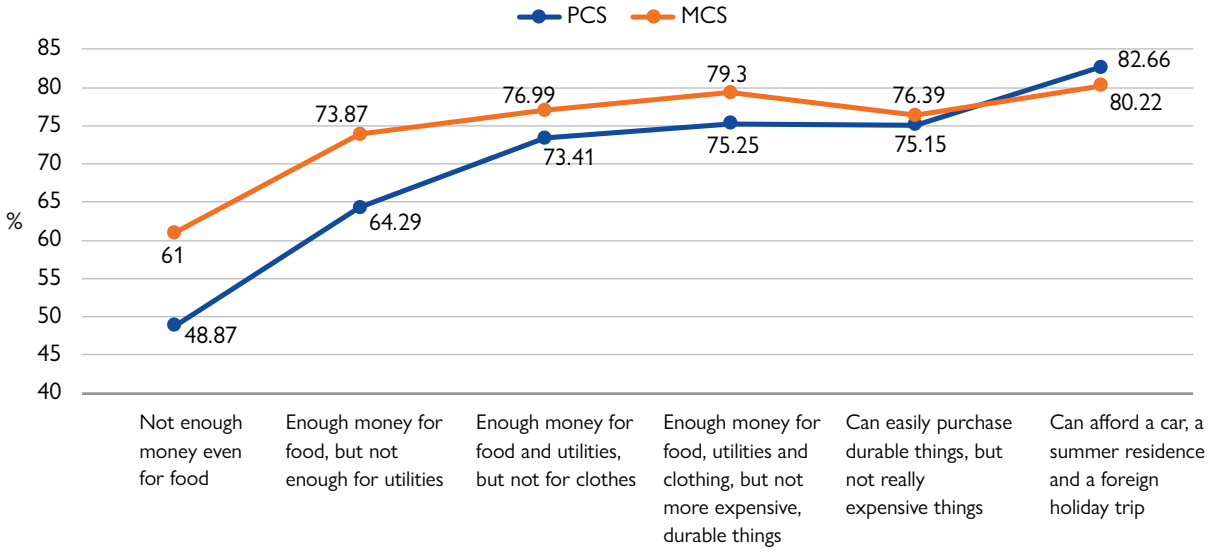


Figure 20. PCS and MCS marginal averages, by gender



The ANOVA results show statistically significant differences in self-reported physical (p=0.04) and mental (p=0.04) health status of men versus women, which means that mental health is more affected by sex rather than physical health.

Figure 21. PCS and MCS marginal averages, by financial situation

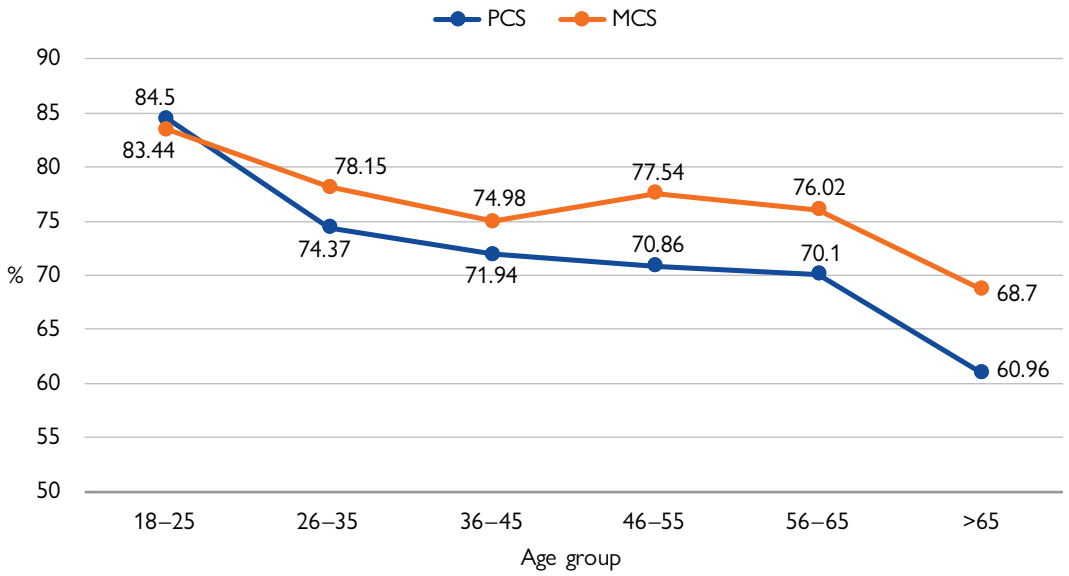


On the other hand, financial situation has no or very little effect on the mental health of respondents (p=0.13). However, there is an association between financial situation and physical health. Figure 22 shows that when one's financial situation improves, so does his or her physical health (p<0.001). This suggests that financial situation strongly influences the overall physical health of residents.

Table 2. ANOVA (analysis of variance) of PCS and MCS scores

Source	F	Significance	Partial eta squared (η^2)
PCS	4 772	.000	.041
MCS	1 705	.131	.015

Figure 22. PCS and MCS marginal averages, by age

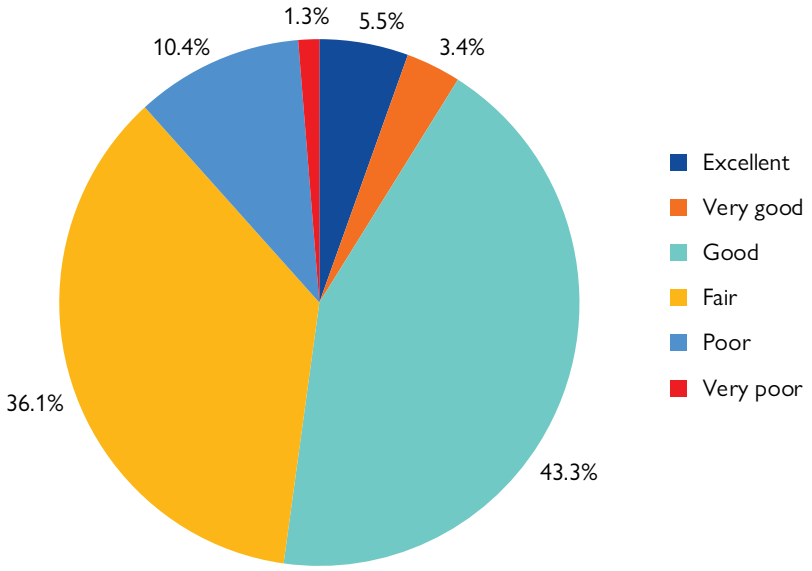


Age has a stronger influence on the physical health (p=0.00) than the mental health (p=0.04) of respondents.

All three independent variables – sex, age and financial situation – individually influence the physical and mental health of respondents, with a significant joint effect on overall physical health (p=0.02).

Prior to studying the respondents' specific health symptoms associated with air pollution, they were asked to rate the overall state of their health (questions from the SF-8 questionnaire) during the four weeks prior to the survey: 43.3 per cent of the respondents answered that they felt "good"; 36.1 per cent, "fair"; 10.4 per cent, "poor"; and 1.3 per cent, "very poor" (Figure 23). One of the reasons for the high proportion of respondents giving their own health at least a "fair" rating can be explained by the Kyrgyz cultural norm of not saying that they feel bad even if they have considerable health symptoms.

Figure 23. Respondents' self-assessment of their health over the last four weeks



The share of people who feel well declines with increasing age: 55.9 per cent of people under 25; 48.2 per cent of 26- to 35-year-olds; 44.7 per cent of 36- to 45-year-olds; 38.7 per cent of 46- to 55-year-olds; 36.1 per cent of 56- to 65-year-olds; and only 32.3 per cent of people over 65. The older the respondents, the worse they feel – an observation associated with age-related health factors.

Health problems limit daily physical activity in 27.5 per cent of respondents (Figure 24), and 14.5 per cent could not fully cope with normal everyday tasks due to minor emotional and personal problems (Figure 25).

Figure 24. How much physical health problems have been limiting respondents' physical activity

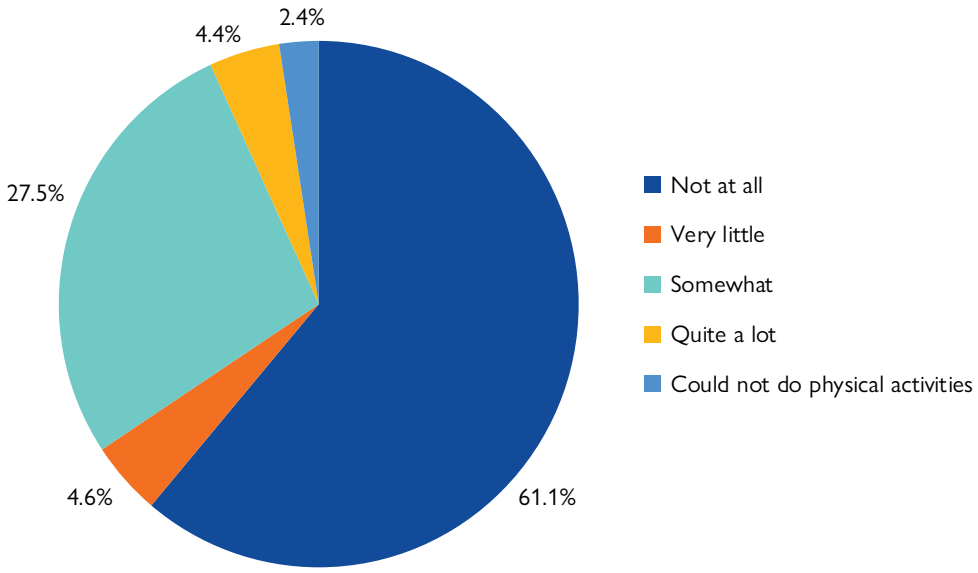
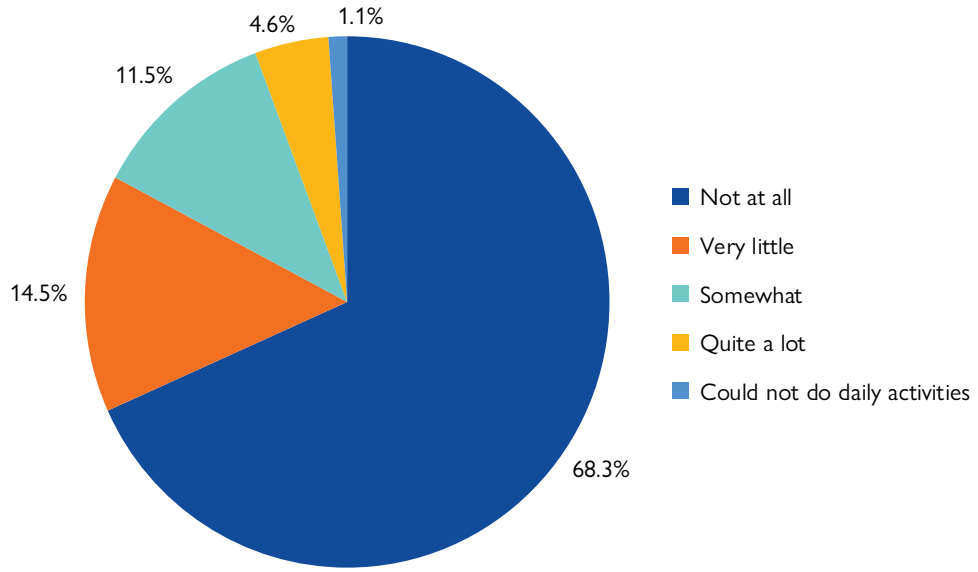


Figure 25. How much personal or emotional issues have been limiting respondents from performing their daily activities



Health symptoms of respondents potentially due to air pollution

Every third household survey respondent report experiencing frequent headaches and dizziness, dryness and irritation of the nose, eyes or throat or shortness of breath since moving to their residential neighbourhood. The type of fuel used for household heating and the length of residency in the neighbourhoods appear to contribute to the increase in health issues. For example, 10 per cent of respondents who heat their homes with coal and have lived in the studied neighbourhoods for up to three years report symptoms such as breathing difficulties, shortness of breath and chronic cough. This figure increases to 30 per cent among those who have lived in the neighbourhoods for more than 16 years (Figure 26).

Figure 26. Health symptoms and illnesses among respondents living in coal-heated homes, by length of residency in their current neighbourhoods

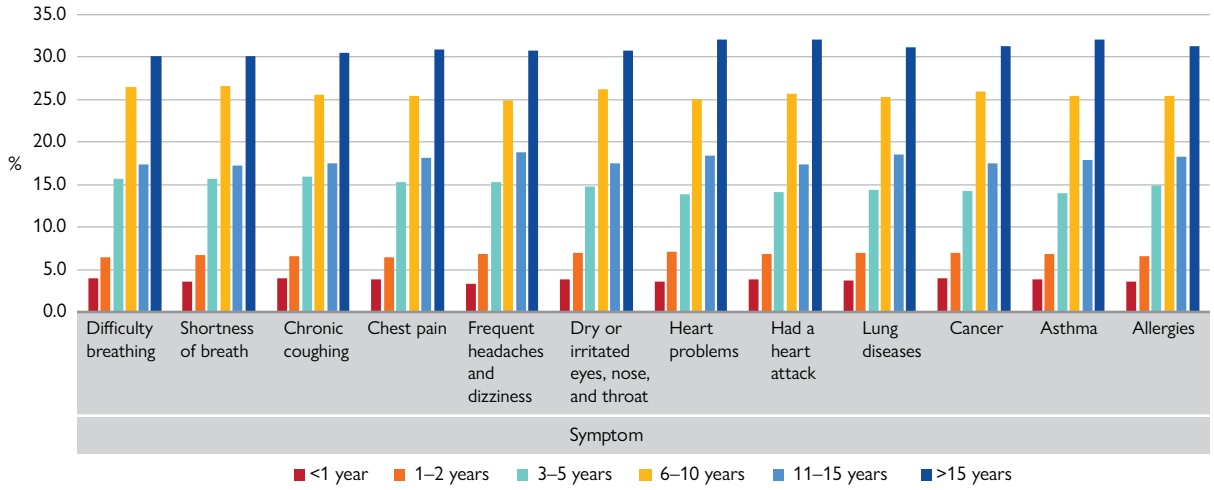
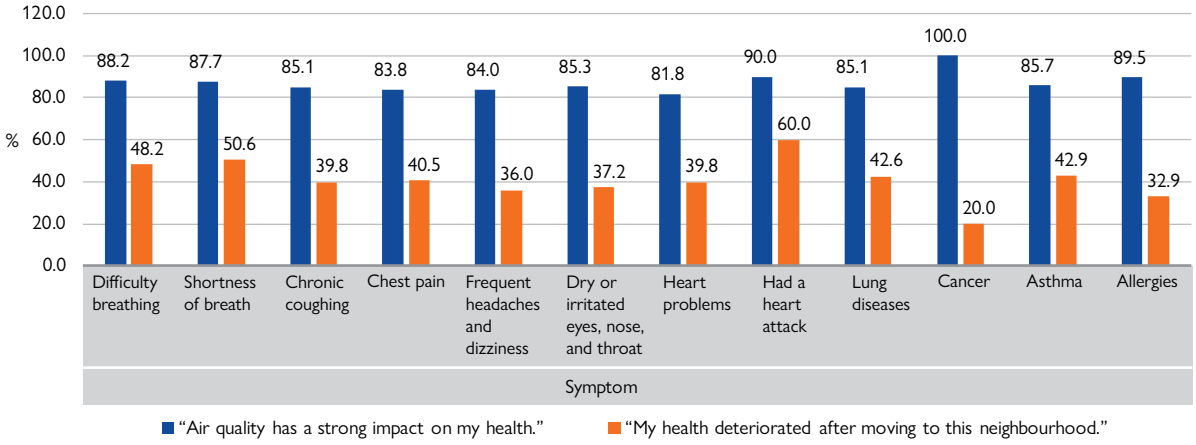


Figure 27. Health impacts attributed by respondents to the air quality in their neighbourhoods



Almost all respondents connect the health problems they have been experiencing since moving to the studied neighbourhoods to poor air quality (Figure 27). Almost all recognize the negative impacts of air pollution on the health of the elderly, children and people with pre-existing respiratory disease.

FGD participants and physicians working in the studied residential neighbourhoods, as well as representatives from the Ministry of Health of Kyrgyzstan, acknowledge the link between air pollution and the increase in health symptoms among residents living in these neighbourhoods. FGD participants and key informants also mention disorders such as chronic obstructive pulmonary disease (COPD), various allergies, allergic cough, bronchial asthma, bronchitis and cancer. Most FGD participants also note the deterioration of their health, especially over the past few years, due to air pollution.

Health is affected by one's workplace environment, as stated during the FGDs. Sewing factories in these neighbourhoods, for example, are characterized by large accumulations of dust and stale air. Workers at these small companies typically suffer from bronchitis or bronchial asthma. In addition, the overall duration of symptoms experienced by participants with mild viral diseases has increased.

"As soon as there is smog, she [a resident of one of the residential neighbourhoods] loses her voice, and in winter this is a constant phenomenon. First of all, children suffer. Over the past two years, there have been a lot of lung diseases. ...A viral cough used to last no more than a week, and now it lasts for 15–20 days. Only dry cough, no fever, no pneumonia – all of these I associate with the air."

Ministry of Health representative, Archa-Beshik residential neighbourhood

"The main diseases are COPD, asthma, bronchitis and allergies, and it is all related to the air – because when residents leave to see relatives, for example, they see an improvement in their health condition. But then they have to return [to their residences] because of the impossibility of permanent residence outside the city."

Physician, Enesai residential neighbourhood

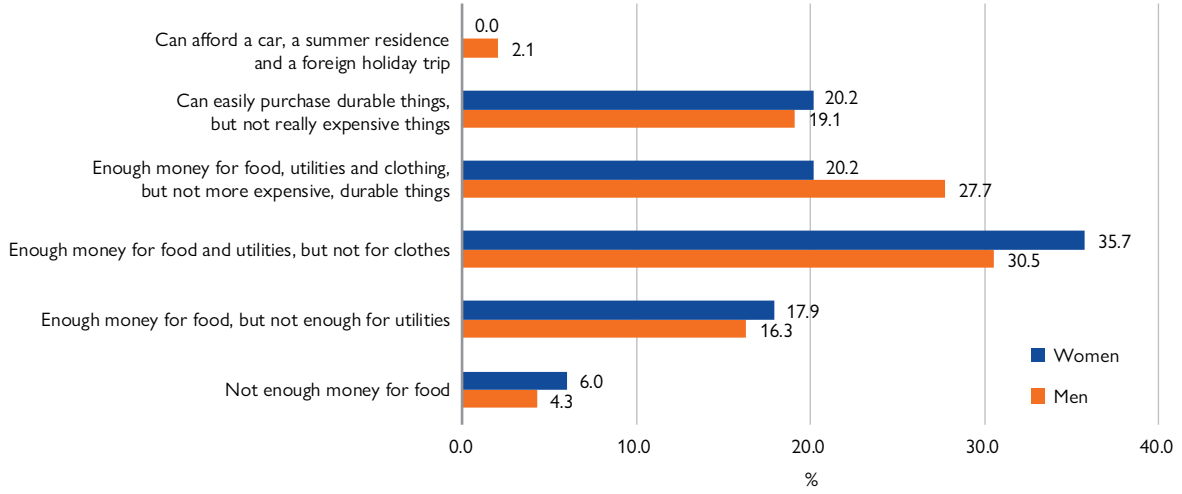
Some FGD participants claimed that when they go to a village or another city with less polluted air, they tend to feel better and their symptoms improve. In addition, it is perceived by some respondents from studied residential neighbourhoods where gas heating infrastructure have already been built that the air has become cleaner and that residents experience allergies and various lung diseases less often than before. Respondents state that, besides the unavailability of gas heating in most neighbourhoods (leaving households to use other types of fuel, including low-quality coal), the TPP contributes to poor air quality, further worsening the health of residents living in the neighbourhoods targeted by the study.

In addition to physical health, air quality could also affect psychological and emotional well-being. FGD participants report that they sometimes experience lethargy, fatigue, emotional intemperance and nervousness in their behaviour – which could be related to poor air quality. They explain that they are tired of living in constant smog and being subjected to unpleasant odours, both indoors and outdoors. In the winter, residents cannot even hang their laundry outside to dry, as it becomes gray or black from the ash in the air, and children cannot play outdoors. Respondents also suggest that poor air quality affects the psychological well-being of household members, friends and neighbours (42.1% partially agreed with this opinion; 8.3% largely or fully agreed with it; 23.4% were unsure).

FGD participants underline that women may be more affected by the poor air quality, as they are more likely to use the stove and tend to stay indoors doing household chores. On the other hand, some FGD participants express that men are equally affected by poor air quality, as they are engaged in heavy outdoor manual labour. As noted during the FGDs, there is a problem concerning busy parents in the studied residential neighbourhoods. Parents are at work from early morning till late at night. As a result, they are unable to monitor changes in their and their children's health and consult doctors on time. This leads to a cumulative effect, as illnesses and/or symptoms are left untreated, resulting in failures in the body at a much larger scale than if residents seek medical help right away.

Financial situation and sex have weaker negative influence on health symptoms than length of residency in neighbourhoods with polluted air. Frequent headaches and dizziness are reported by most of the household respondents regardless of gender and income (Figure 28). The same is true of dry and/or irritated eyes, nose and throat, as well as breathing difficulties.

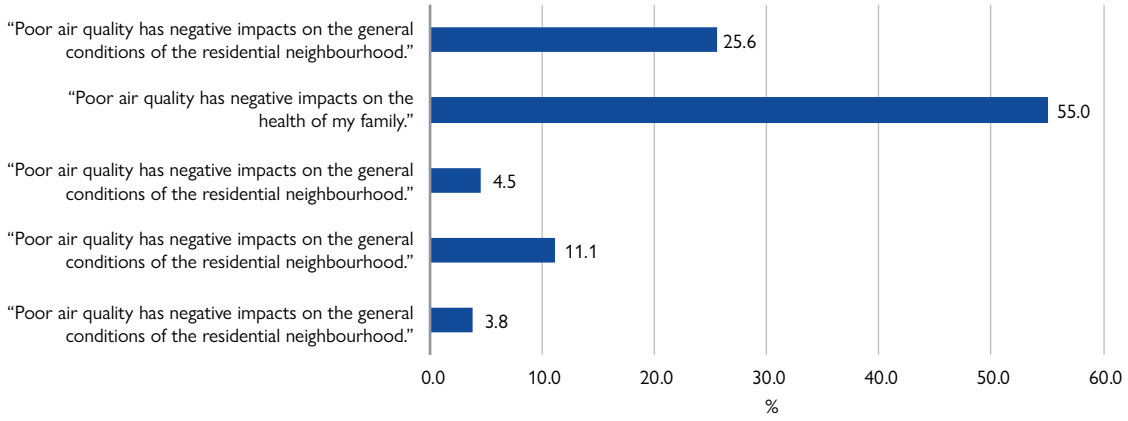
Figure 28. Percentage of respondents reporting frequent headaches and dizziness, by gender and financial situation



Actions to improve air quality and information channels

Most survey respondents (64.6%) and KII and FGD participants agree that improving air quality should be a top priority among the long list of problems that need to be resolved in the studied residential neighbourhoods. Among survey respondents who list poor air quality as a key problem to be addressed, 55 per cent state that air pollution negatively impacts their families' overall health (Figure 29). Residents note frequently recurring symptoms, primarily related to lung and heart diseases that worsen during the autumn and winter.

Figure 29. Reasons respondents believe that air quality is an important issue



Those who do not consider air pollution to be a problem tend to be either unaware of its health implications, have generally pessimistic sentiments or are planning to move out of the studied neighbourhoods.

FGD and KII participants provide more in-depth information about actions that the Government and various organizations have already taken to improve air quality in the neighbourhoods. NGO and other initiative-focused groups have played an important role in mainstreaming the issue of air pollution and finding solutions.

So far, MTUs have conducted educational sessions about the harm of burning leaves in the autumn and how it affects air quality, carrying out small, targeted campaigns in selected neighbourhoods about modern household heating methods. In 2018, the National Government created an interdepartmental working group that developed a five-year plan to improve the environmental situation in Bishkek. Among concrete actions being taken include the prohibition by the Bishkek City Mayor's Office of the use of fireworks in the city during the New Year holidays. MTUs organize periodic raids on small businesses to enforce and monitor compliance with the ban on the burning of solid waste, plastics and other harmful materials that business owners use for heating. In addition, gas heating infrastructure is (gradually) being developed in neighbourhoods around Bishkek.

All respondents agree that one key government body that can help resolve the air pollution problem is the Bishkek City Mayor's Office. Other local authorities can provide assistance in tree-planting, laying of gas pipes, improving public infrastructure and garbage collection; through subsidies for renewable energy or energy efficiency improvements in homes; and by organizing meetings about air quality and other awareness-raising activities.

MTU representatives mention that they periodically hold meetings and events with health workers to raise awareness about air quality, the effects of poor air quality on health and contributions that everyone can make to reduce air pollution. Additionally, these representatives work to manage the use of harmful fuels for heating. For example, these authorities can impose fines for violations of the regulations. For low-income households that only have solid waste (such as sewing leftovers) as the available and affordable heating fuel, such fines are often waived. Incentives, rather than punitive measures, could therefore be considered.

"I believe the MTU is working on this. …In our conversations with residents, we also tell them that burning waste products is undesirable because they are harmful to our bronchopulmonary system. Yes, explanatory work is done. At the MTU, when meetings are held, we constantly remind them about it."

Physician, Madaniyat residential neighbourhood

"Our local administration [MTU] representatives work on these issues. If residents see such violations, they notify the sanitary and epidemiological station, the local administration representative. Yes, explanatory work is carried out. Residents are aware, and if someone burns rubber, sewing waste or leaves in the gardens, they take pictures and send photos to the local administration representative. And the local administration representatives – as far as I know – fine them. It was about three to five years ago when these fines were introduced."

Physician, Ala-Too residential neighbourhood

In addition to government agencies and NGOs, up to 85 per cent of survey respondents indicate their willingness to act on improving air quality, or that they already take part in various such initiatives. The largest number of respondents are willing and ready to switch to cleaner energy and cleaner heating systems, 83.9 per cent and 80.5 per cent, respectively. As for other measures, 72.8 per cent are ready to participate in the sorting of solid waste and 71.4 per cent in planting, with 57.2 to 67.6 per cent indicating that they would avoid burning solid waste, conserve drinking and irrigation water, improve the energy efficiency of their homes, including by installing energy-saving light bulbs, and use public transportation. Among those already engaged in these practices, the most common are using of energy-saving light bulbs (36.7%), taking public transportation (36.3%), conserving drinking and irrigation water (30.6%), conserving fuel (gas and coal) (31.4%), not using solid waste as fuel for residential heating (28.6%) and improving the energy efficiency of their home design (22.8%).

Despite the high percentage of survey respondents who are willing to take part in initiatives and activities aimed at improving air quality, some respondents say they would not be able to if it would put a significant strain on the household budget. More than two thirds (69.8%) believe that everyone is responsible for the air quality in their residential neighbourhood. In addition, more than half (51.1%) believe that changing the environmental situation is the responsibility of each resident, and therefore will be ready to participate as much as possible. More than a third (36.9%) are ready to contribute to improving air quality only if it will not significantly impact their household budget. Only 8.6 per cent said that they would not be able to allocate even the minimum amount from their household budget for this purpose.

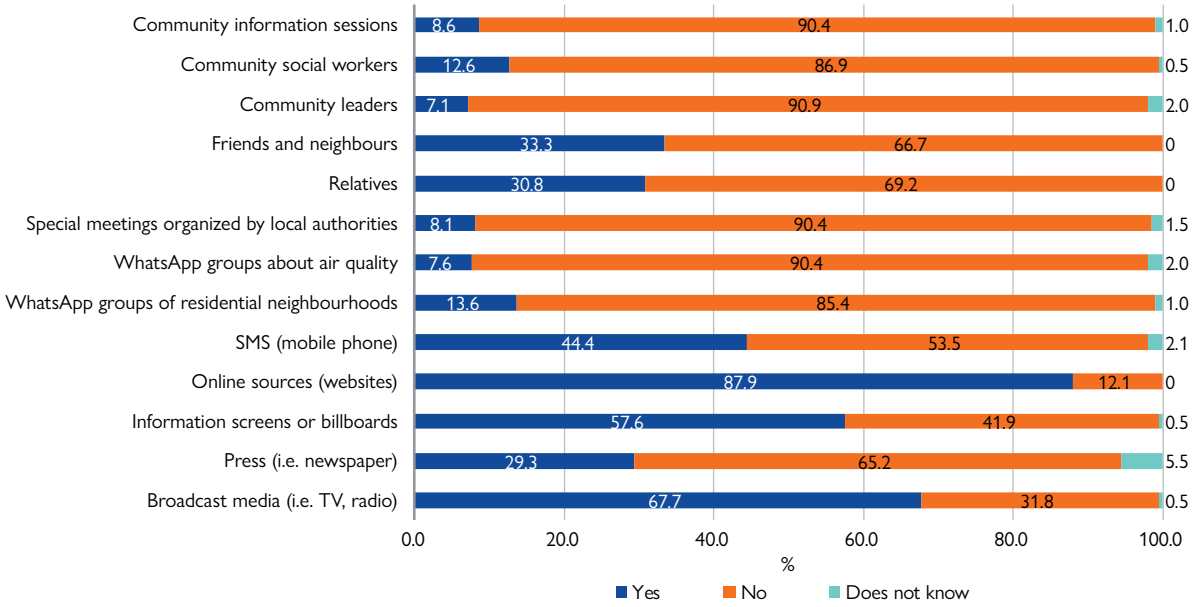
FGD and KII participants believe that both the elderly and the working-age population, as well as the young generation, which include students, can be actively engaged in actions towards improving air quality in residential neighbourhoods.

In general, the study found that over the past five years, various organizations have been carrying out a range of activities, primarily on raising awareness, aimed at improving air quality. However, these activities are still not systematic and do not cover the entire population of the residential neighbourhoods nor all of the neighbourhoods. Despite the awareness and understanding of the residents of this issue and their readiness to contribute to solving the situation, many household incomes are unable to accommodate expenses that are unrelated to basic needs.

Some two thirds (67.8%) of survey respondents indicate that information about air quality in the residential neighbourhoods is not provided regularly.

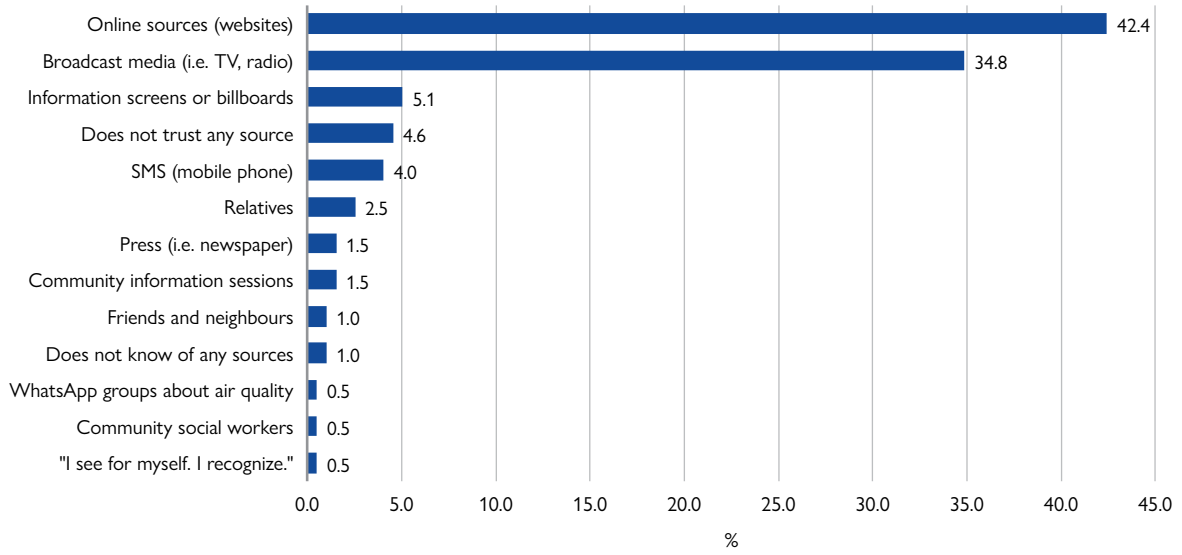
Figure 30 shows the channels of communication through which residents receive information about air quality. The most popular and frequently used channels of information are online resources (87.9%), broadcast media (67.7%) and information screens or billboards (57.6%).

Figure 30. Information channels used to receive information about air quality



Most of the respondents trust information about air quality from online resources and broadcast media like television and radio (Figure 31).

Figure 31. Most trusted communication channels for information on air quality



Children of a residential neighbourhood in Bishkek.
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DISCUSSION OF FINDINGS

Elevated concentrations of PM2.5 and other air pollutants in the air of Bishkek have an uneven impact on city dwellers, posing a greater risk to the health of residents of the surrounding residential neighbourhoods, comprising mostly internal migrants, than to the residents of the city itself, particularly during the heating season. Health consequences from air pollution are felt year-round in neighbourhoods situated near industries, highways and landfills. Due to growing internal migration in Kyrgyzstan and the arrival of working-age individuals in the capital city, Bishkek, population density in these areas is high and population continues to grow. As a result, neighbourhood air pollution will continue to be a public health concern for years to come, necessitating the urgent need for comprehensive action.

One of the main factors contributing to air pollution is the use of coal for heating by a large number of local residents in the autumn and winter. Other factors – exerting their effects throughout the year – include the lack of garbage bins and green spaces, irregular waste collection by MTU services, dust from unpaved roads, poor air circulation and high population density in residential neighbourhoods.

Almost all respondents – residents and experts alike – report health problems, which they link to poor environmental conditions and poor air quality in the studied residential areas. These include an increase in symptoms such as frequent headaches and dizziness, dryness and irritation of the nose, eyes and throat, allergies, shortness of breath, chronic cough, chest pain and heart problems since moving to the residential neighbourhoods. These symptoms are recurrent in most of the residents with the onset of the heating season. Some of these health issues may have been influenced by COVID-19, with part of the field phase coinciding with the fourth wave of the pandemic in the country. Health issues are exacerbated by the fact that many residents have limited economic means and almost half of the survey respondents living in these neighbourhoods on the outskirts of Bishkek do not yet have residence permits, thus preventing them from accessing free public services, including health and education. There is no complete data from the Ministry of Health on disease prevalence among residents living in the studied residential neighbourhoods.

Respondents note that if the detrimental health effects of air pollution are thoroughly explained, then residents would be willing to convert to better-quality coal. However, even while respondents also note that air quality in neighbourhoods that have been connected to gas heating has improved, there is a reluctance to switch to gas and electric heating. Residents, including internal migrants, living in the studied residential neighbourhoods are also willing to take responsibility and adopt more environmentally friendly practices, such as sorting solid waste, planting trees and improving the energy efficiency of their homes so long as such improvements do not have a drastic impact on their finances, as most of them have low incomes.

With respect to home construction, the study reveals many opportunities in insulation and heat retention. Most of the residents, including internal migrants, living in the residential neighbourhoods built homes for their own use and, consequently, would be interested in making them energy-efficient, as it would allow them to save on fuel. However, some FGD participants reveal that tenants would not be interested in investing in energy-efficient features for homes they are merely leasing because with insulation, they need to rely less on heating. Educational programmes on new, low-cost technologies for constructing energy-efficient homes may also be considered, as there are ongoing construction activities in the studied neighbourhoods.

Albeit unsystematic, there have been some attempts to address the issue of air pollution in the residential neighbourhoods by the Government, civil society and the neighbourhoods' residents. Regularizing these neighbourhoods and connecting them to the city infrastructure would build the foundation for a comprehensive plan of action that includes all stakeholders in the fight against air pollution. To strengthen awareness of the impacts of air pollution on human health, it would be important to continue raising the awareness of these residents, including internal migrants, on this subject.

RECOMMENDATIONS

The study has shown that a multiplicity of determinants affects household air pollution. Several measures may be proposed at different government levels to address them. The National Government can play a lead role in implementing effective environmental regulations (including by imposing stricter air quality standards and limiting air emissions), strengthening environmental governance, and creating livable cities. It is essential to implement policies, drafted in collaboration with health authorities, with the dual goals of reducing air pollution and enhancing the health of vulnerable populations including internal migrants.

Specific measures that can be implemented by the National Government and the Bishkek City Mayor's Office are listed below.

Government of Kyrgyzstan

(a) Develop a presidential programme to improve air quality, mandatory for implementation by the relevant government agencies. The status of the document at the presidential level will ensure clearer and more consistent implementation, and constant monitoring of the results. Thus, the formation and execution of a systematic national policy on this issue will be ensured. It is necessary to start implementing the Law of the Kyrgyz Republic "On the Energy Efficiency of Buildings", which will improve thermal insulation of homes and expand the use of cost-effective heating systems. It will be necessary to inform the population about heat loss and energy-efficient solutions for residential neighbourhoods.

(b) Accelerate the process of connecting residential neighbourhoods to gas heating. Towards this end, it will be necessary to work out special agreements between gas suppliers and the Government, in which approximate timelines for the "gasification" of neighbourhoods should be indicated.

(c) Develop a subsidy policy for the residential neighbourhoods, in order to reduce tariffs for gas or electric consumption, to be on par with the cost of using coal to heat homes and their premises.

(d) Review and tighten requirements for private bathhouses, workshops and factories operating in residential neighbourhoods, in order to prevent their use of harmful heating fuels.

(e) Consider and approve methods of storing ash from the TPP that do not harm the environment and the health of residents of adjacent residential areas.

(f) At the legislative level, it would be necessary to introduce a ban on the use of plastic dishes, utensils and bags (used in food and retail establishments) – waste material often used for heating in private homes and bathhouses in residential neighbourhoods.

(g) Develop and implement a strategy on environmentally sustainable behaviour and lifestyle throughout the country.

(h) The Ministry of Health of Kyrgyzstan could develop an action plan for the population of Bishkek for the prevention and treatment of non-communicable diseases associated with air pollution.

(i) The Ministry of Health, together with the Bishkek City Mayor's Office, could look into options to improve access to health services by internal migrants without residence permits, to allow for timely treatment of diseases.

(j) The Ministry of Health, together with HydroMet and the Bishkek City Mayor's Office, could develop the Air Quality Index, which will allow the population to get up-to-date information about air quality and protect their health when there are high concentrations of air pollutants.

(k) Discussions of the problem of air pollution, the attitudes and behaviour of the population, the impacts of air pollution on health, and actions that could be taken by everyone to help address the issue could be disseminated through social media platforms and webpages that are popular among different age groups and Internet news sites.

(l) Brief information reviews or digests about air pollution and mitigation measures could be broadcast regularly on State television channels and radio channels, as well as by private news agencies, either before, during or after a news programme (following the principle of "broadcasting the weather forecast"), to maximize information outreach – that is, to cover not only the residential neighbourhoods around Bishkek, but the entire population.

Bishkek City Mayor's Office

(a) Integrate actions and activities aimed at reducing air pollution in the residential neighbourhoods around Bishkek in all of the Bishkek City Mayor's Office programmes, workplans and other guiding documents.

(b) Introduce the regulation in the residential neighbourhoods to plant trees and shrubs adjacent to homes, as well as considering incentives instead of penalties for using water for watering green spaces.

(c) Expand the work of the municipal service responsible for timely solid waste collection and installing trash bins in residential neighbourhoods so that residents stop burning household waste for heat.

(d) Develop a systematic and continuous information campaign, targeting all residential neighbourhoods, about the harm that poor air quality causes upon health, the cost of medical treatment, and the need to use better-quality coal.

(e) Install educational posters; produce and distribute infosheets; and develop and launch social media channels.

ANNEX

Sample distribution by residential neighbourhood

No.	Residential neighbourhood	Number of households	% of total households	Initial sample size	Final sample size
1	Ak-Bata	1 076	2.99	18	18
2	Ak-Bosogo	3 515	9.77	58	58
3	Ak-Orgo	3 350	9.31	55	55
4	Ak-Tilek	435	1.21	7	10
5	Ala-Too	1 495	4.16	25	25
6	Altyn-Beshik	430	1.2	7	10
7	Altyn-Ordo	1 034	2.87	17	17
8	Archa-Beshik	5 658	15.73	93	93
9	Bakai-Ata	1 160	3.22	19	19
10	Chon-Aryk	1 076	2.99	18	18
11	Dordoi	1 136	3.16	19	19
12	Dordoi 2	448	1.25	7	10
13	Enesai	520	1.45	9	10
14	Jenish	505	1.4	8	10
15	Kalys-Ordo	1 945	5.41	32	32
16	Kelechek	1 076	2.99	18	18
17	Kok-Jar	3 995	11.11	66	66
18	Kolmo	670	1.86	11	11
19	Krasnyi Stroitel	339	0.94	6	10
20	Madaniyat	327	0.91	5	10
21	Muras-Ordo	2 254	6.27	37	37
22	Ruhiy-Muras	960	2.67	16	16
23	Tokoldosh	903	2.51	15	15
24	Tynchtyk	577	1.6	9	10
25	Uchkun	1 085	3.02	18	18
	Total	35 969	100%	*N* = 593	*N* = 615

Source: Data on the number of households per residential neighbourhood (2020) was provided by the Bishkek City Mayor's Office.

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