# Do we need rooftop gardens?

# The benefits and personal experience of rooftop gardens in multi-family housing in Seattle.

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## Abstract

Do people need rooftop gardens? The self-reported benefits and personal experience of rooftop gardens in multi-family apartment buildings in Seattle.

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This research studies peoples' experiences of rooftop gardens in select Seattle multi-family apartment buildings and attempts to determine how residents benefit from them. As the population in Seattle increases, less ground-based, public open space is available, and rooftop gardens have emerged as a building-based design feature offering residents the opportunity to enjoy the outdoors. But what do people think of these spaces? How do they use and experience them? Do they feel better after visiting the rooftops? I conducted an online survey of apartment building residents in Seattle buildings to understand these questions better. This survey's results (n = 64) reveal that residents benefit from using rooftop gardens, enjoy different features and opportunities these spaces can bring, experience them in different ways, and would like to see more of the specific features that this research explores. Based on this survey, people mostly

appreciate the opportunity to simply access fresh air; enjoy the views from their rooftops; the plants, both aesthetic and productive; their use for relaxation, recreation, and socializing; and more experiences. Research demonstrates that cities and the natural environment benefit from rooftop gardens, but people also benefit from them, use them and enjoy them. The findings can be helpful for future building policies and regulations governing new construction or the renovation of existing buildings. They can be used to promote rooftop gardens in Seattle and other cities.

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# GLOSSARY OF TERMS

This page lists terms used throughout this research or created for this thesis. All the terms below are explained within the body of the text.

- *Experience of Rooftop Gardens*: throughout this research, this includes the usage, preferences, and opinions of the roof garden visitors - people's favorite features, the things they would like to add, how people spend time there, whether they feel better after the visit, and why.
- *Green Roof:* including fully planted roofs, which are also called extensive green roofs and do not include any amenities but are heavily planted; and mixed-use roofs with plants in planter boxes and amenities - called rooftop gardens, or intensive green roofs, that require more maintenance (McIntosh, 2010).
- *Nature-Deficit Disorder (NDD)*: unofficial "disorder" not currently recognized as a medical diagnosis, yet based on studies that show the negative effect on people, especially children, when they do not spend enough time in nature and have behavioral, physical, and psychological issues and "even can change human behavior in cities" (Louv, 2005, p. 36). Richard Louv introduced the term in 2005 in his book Last Child in the Woods: Saving Our Children from Nature-Deficit Disorder.
- *Rooftop Garden or Roof Garden:* park-looking, not heavily-planted roofs with plants in planter boxes and amenities, called rooftop gardens or intensive green roofs (McIntosh, 2010).

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# Chapter 1. Introduction

We live in a world of rapid urbanization. The pace has increased enormously in recent decades and is projected to continue rising in the coming years (United States Environmental Protection Agency, 2023). The World Health Organization states that around 68% of the world's population will move to cities by 2050 (World Health Organization, 2022). This population growth in urban areas is correlated to a decrease in the available per-person open spaces in these areas, a rising concern for policymakers and city managers (Nikkhou & Tezer, 2020).

With increasing populations also comes increasing land prices (Balk, 2021), and parcels set aside for open space are decreasing as private developers seek to maximize income-generating development capacity. (Wilonsky, 2017). As a result, building density increases, and ground-level vegetation and open space decreases (Wong et al., 2010). Despite this trend, resident demands for open and recreational spaces remain, and research has shown that urban residents benefit from even small green spaces such as pocket parks, flower beds, and trees through physiological restoration opportunities and recreational and experiential benefits (e.g., Nordh et al., 2009; Lindall & Hartig, 2015). Therefore, this research focuses on one of the green space types - rooftop gardens, as a part of the modern urban environment, the solution for the urbanized areas with expensive land and free land scarcity. Their benefits and people's experience of these spaces will be studied and discussed further.

Furthermore, in recent decades, the concept of "nature deficit disorder" has emerged and become popularized by researchers and the media (Nikkhou & Tezer, 2020). Though the disorder is not official in the International Classification of Diseases and Related Health Problems, it is associated mainly with children who are increasingly deprived of direct contact with nature (Driessnack, 2009, (Louv, 2005). Nature-Deficit Disorder (NDD) consists of mental and physical

issues due to excessive time spent inside buildings, a sedentary lifestyle, and built-up urban environments. It is often related to obesity, diabetes, hypertension, vitamin D deficiency, attention-deficit/hyperactivity disorder, depression, and other symptoms (Driessnack, 2009). As it is primarily discussed in the context of childhood issues, many researchers believe that adults suffer from the same set of problems.

Sustainable approaches to urban development are becoming more commonplace globally (Hoden et al., 2014). A central aspect of such approaches is seeking opportunities for preserving and enhancing remaining open spaces, an area of study that has been intensely researched. In addition, cities worldwide urgently need to restore the connection between people and nature and be sustainable and environmentally friendly, and they need to understand how to plan and build for a sustainable future (Crane et al., 2021).

One of the solutions that could bring benefits both to the residents and to the developers is providing green space on the rooftops and constructing parks, farms, or gardens there without using any additional land. Such strategies benefit city residents and attract renters and buyers. They also address environmental issues common to cities; they decrease the urban heat island effect, decrease runoff, increase oxygen levels, and absorb carbon dioxide. They also provide wildlife habitat and increase overall biodiversity (Cabral et al., 2017). Rooftop gardens can affect people personally, bringing social benefits, promoting health and well-being, and serving the public good (Cabral et al. 2017).

This research asks if rooftop gardens impact people's lives and allows us to better understand these impacts and better recognize the specific qualities of rooftop gardens that provide benefits. This study is intended to assist developers, planners, and city managers in understanding how rooftop gardens on top of multi-family apartment buildings benefit city residents. It will also

show whether it is worth, from the perspective of social benefits, building such spaces. Perhaps it better to just build green roofs, which would still provide environmental benefits.Furthermore, it may encourage making rooftop green spaces more ubiquitous and be built more often on a higher number of affordable housing units, addressing equity issues and making rooftop gardens accessible for more people, as this study can bring valuable fundings that could be used in the future design of residential buildings. Unfortunately, there are not many studies on how people experience, use, or benefit from rooftop gardens, and none focusing on Seattle. That is a contribution of this study.

My research questions are:

1. How do the users of the rooftop gardens in Seattle multi-family apartment buildings experience them?
2. How do the users of the rooftop gardens in Seattle's multi-family apartment buildings benefit from them?

I developed an online survey for residents of apartment buildings in Seattle with rooftop gardens and received 64 responses. The results reveal that people feel better after using the rooftop gardens and see different values in them. This information can assist city planners, architects, and designers. It also provided information on the favorite features of the gardens, on what features are lacking, and explained why specifically people felt better after spending time on their rooftops. The data and findings of this study can be considered for designing and planning new apartment buildings or retrofitting existing roofs.

In the following chapters, I will review the literature about the history of green roofs, their benefits, growing popularity, how people experience green roofs and how these spaces impact people's health, as well as accessibility issues of the green roofs. Further, I will describe the

methods of this research. Descriptive statistics and a comparative analysis of the findings will be provided next. After, there will be a discussion of the findings section, followed by the limitations and future directions chapter and the applications and recommendations chapter, and ending with the conclusion.

# Chapter 2. Literature Review

## 2.1 WHAT IS A ROOFTOP GARDEN

### *2.1.1 Green Roofs and Rooftop Gardens*

In a *Survey of Vegetated Roofs and Rooftop Gardens*, a document for the City of Seattle and the University of Washington Green Futures Lab, Annika McIntosh mentions that "there are multiple terms used to describe a vegetated roof" (McIntosh, 2010, p. 2). She states that The City of Seattle uses the term "green roofs" for both: heavily planted roofs, also called extensive green roofs, and park-looking roofs with planter boxes, more maintenance, and amenities, called rooftop gardens, or intensive green roofs. The document states that the second type is usually more accessible to visitors. Intensive green roofs differ from extensive ones as they allow diverse utilization of roofs - as an open space, food growing platform, or place for recreation (Peck et al., 1999).

Seattle rooftops often have a mixture of these two types (McIntosh, 2010). This research concentrates primarily on intensive rooftop gardens with access for residents. An excellent example of an extensive green roof is the Neptune Apartments complex (Figure 1). An example of an intensive green roof or rooftop garden type \is found  on the Batik Apartment Building (Figure 2). This garden is located in a multi-family apartment building, allows residents to visit, and has multiple amenities and greenery in raised beds or planters.

*Figure 1. Extensive Green Roof Example. Seattle Cancer Care Alliance roof. Photo Credit: Annika McIntosh, 2009*

*Figure 2. Intensive Green Roof Example. Batik Apartments Roof. Photo Credit: Vulcan Real Estate, 2018*

### *2.1.2 A Short History of Rooftop Gardens*

Even centuries ago, green roofs were a landscape feature in Babylon Gardens, Roman Empire's institutional buildings, and Viking houses (Peck et al., 1999). However, the oldest roof garden was found in ancient Mesopotamia, "built from the fourth millennium until 600 BCE" (Magill et al., 2011, p. 2). Later, during the Renaissance period of Europe, they became popular in many parts of the planet and were found in India, Spain, France, Georgia, and other countries (Peck et al., 1999). These structures existed for beautification, protection of the buildings from weather conditions, and to provide shade. Unfortunately, they also leaked and attracted harmful insects, so concrete roofs became their substitute (Stewart, 2013).

However, the idea of intensive green roofs re-emerged in the 1900s. They were enhanced, made with new technologies, repelling agents, drainage systems, and lighter elements (Peck et al., 1999). European cities developed policies and supported planning regulations that included greening of the buildings, mainly for stormwater management (Peck et al., 1999). Britain used green roofs as camouflage for military airfield hangars in 1930 (Magill et al., 2011). "In Germany, France, Austria, Norway, Switzerland, and other European states, green roofs have become a commonly accepted feature in the construction industry and a welcome feature of the urban landscape" (Peck et al., 1999, p. 12).

In the United States, however, green roofs were introduced only recently, becoming more popular during the last several decades. One of the North America's first recognizable vegetated roofs was New York's Rockefeller Plaza, constructed in 1931 (Stewart, 2013). However, quite noticeable rooftop gardens in the US were built earlier, such as the Roof Garden in Astor Hotel in New York, built in 1904. Drawings and pictures of the Astor Hotel Garden, dated from 1905, are located in the Museum of the City of New York. (Museum of the City of New York, n.d.). This garded included water features, lush vegetation, a restaurant, and a dancefloor, but an office tower replaced it in 1967 (Ephemeral New York, 2010).

Green roofs have become essential parts of sustainable policies and documents worldwide. For instance, *A Review of Green Roof Laws and Policies* mentioned the Building and Construction Law of 2002 in Basel, Switzerland, requires green roofs on all new and renovated flat roofs; the Ecoroof Requirement of 2018 in Portland, OR, requires green roofs to cover 100 percent of the roofs on new buildings with a building area of 20,000 square feet or more; the Green Roof Law of 2001 for Tokyo, Japan requires vegetated roofs on new buildings with a flat roof area of at least 1,000 square meters; and in Seattle, the Seattle Green Factor implemented in

2006 is an important document that promotes the building of rooftop gardens and vegetated roofs (Savarani, 2019). It is a "core-based code requirement that increases the amount and improves the quality of landscaping in the new development." (City of Seattle). A particular score must be achieved by "developments in specific zoning districts, based on various green landscaping options, including green roofs" (Savarani, 2019, p. 4). City of Seattle Green Factor documentation states that "the use of larger trees, tree preservation, green roofs, green walls, and water features are encouraged by this requirement." (Seattle Green Factor, 2008).

*2.1.3 General Benefits of Green Roofs*

Even as they have a long history, green roofs have much to offer the present, including social to environmental benefits. Green roofs offer advantages in cramped urban settings. Intensive roofs become an amenity, serving as terraces or green spaces. "Whether used to reclaim lost space or simply provide a verdant view, these roofs offer many advantages that extend beyond the obvious benefits to owners and occupants." (Willmert, 2000. p. 182). In addition, green roofs have ecological benefits such as mitigating the urban heat island effect and provide overall cooling, converting carbon dioxide into oxygen (Willmert, 2000). For these reasons, many local governments encourage green roofs and even offers tax incentives to developers who provide them (Willmert, 2000).

Researchers from all over the world have studied the multiple benefits of green roofs and rooftop gardens. Nature, people, urban environments - these structures influence them all. For example, many cities use green roofs in their stormwater management plans to decrease urban stormwater runoff (Netusil, 2022). Moreover, rooftop gardens also can improve urban agriculture, as people can grow food there and educate themselves; green roofs also can reduce noise pollution, absorbing sound waves (Dunnett & Kingsbury, 2004). They also bring visual

pleasure and can educate visitors about nature and ecology (Sutton, 2014). Green roofs and rooftop gardens can also decrease air pollution and greenhouse gas emissions as the vegetation sequesters carbon from the atmosphere and buildings are better insulated, decreasing air conditioning demand, and therefore fewer emissions from conventional power sources are required (EPA, 2023). Green roofs also lower energy costs, create new jobs (US General Services Administration, 2011), increase building value, attract new residents, and provide additional green space and a place for outdoor recreation (Kaufman et al., 2023).

## 2.2 GROWING POPULARITY OF ROOFTOP GARDENS

With sustainability becoming more popular and the urge to act to stop climate change becoming more tangible, the popularity of green roofs is increasing. A Canadian organization, Green Roofs for Healthy Cities, estimates that there are going to be 15 percent more green roofs in North America since 2013 (DiNardo, 2019). People enjoy visiting green roofs more, having them in their private or apartment buildings, and understanding their social and environmental value (DiNardo, 2019). The media often influences these perspectives. “The visibility of green roofs in the media greatly impacts how the public views them and how appealing and realistic they appear to them as an everyday part of life. The more they appear, the more we as regular people feel comfortable with them.” (Tomazin, 2020, p 1). As more people recognize the seriousness of the issues connected to climate change, sustainability becomes more important, and green roofs become a symbol of a particular lifestyle and play a more significant role in people’s lives. They start showing their rooftops and sharing them on social media, and green rooftops and rooftop parks appear more in TV shows (Tomazin, 2020). These resources reveal that green roofs are becoming more popular as more people see their value. Some even claim

that green roofs are an excellent solution for modern urban environments and can improve our cities' livability (Oberndorfer et al., 2007).

## 2.3 HOW PEOPLE EXPERIENCE ROOFTOP GARDENS

As this research is about people's experiences, I explore related research done in different cities of the world. I have found valuable examples in magazine articles in which people share their experiences about the spaces on the roofs of their houses, mention their favorite features, the reasons why they do not go to green roofs, and other information valuable for this research.

Green roof technology and designs are commonly offered as a sustainable solution to a wide range of urban, environmental, and even mental, physical, and social issues, as we see from our literature review. In Malaysia, researchers surveyed people with a questionnaire to understand their opinions of green roof infrastructure (Rahman et al., 2015). The study found that most people liked spending time on the roof gardens; some knew about the benefits of such gardens, especially the ones who noted that they had a higher education. However, most respondents visit the rooftop garden due to its beauty and peace without understanding green roofs' environmental and social benefits. This study's findings suggest that greenery elements such as a green roof help to regenerate and revitalize the commercial setting in an urbanized area. The green roof was perceived as a peaceful place to retreat (Rahman et al., 2015). The researchers also argue that implementing green roofs allows an urban citizen to gain psychological and health benefits through visual and sensory stimulation.

Furthermore, researchers Nyuk and Yuen (2005) were interested in people's perception of rooftop green spaces, which according to the authors is very rarely studied, and how people use those spaces in the cities as public parks, not as amenities in the buildings they lived in . Firstly, people who used the rooftops were interviewed to develop, refine, and pre-test the survey before

the survey was formed. The interesting findings were that many people did not use the rooftops at all; most people would have liked to see more gardens provided as they see several benefits from rooftop gardens in the city. Among the benefits and the motivations for visiting rooftops are "aesthetic pleasure," "the affordance of opportunities for children's play," and "recreation and retreat for peace and quiet moments amidst dense urbanity" (Nyuk & Yuen 2005, p 273).

Another survey was conducted in Seoul, Korea, to understand the public opinion on edible and non-edible rooftop gardens. The results of the survey of 208 people found that 80% of the participants "expressed the necessity for green roofs in urban areas," and 79.3% have chosen non-edible plant gardens over farms [...]. People also perceived the environmental benefits, such as reducing the urban heat island effect and improving the efficiency of rainwater use, as important" (Kim et al., 2018, p. 214). The study helped the authors recognize that improving the economic and environmental sustainability of the rooftops is needed to improve the appeal of rooftop spaces and that there is a high interest in rooftop gardens overall (Kim et al., 2018).

The *Iranian Case Study* explored the expectations and attitudes that citizens have toward rooftop activities related to social, demographic, and behavioral variables (Kalantari et al., 2016). Results articulated the opinions about the essential benefits and problems with living roofs. Many people were interested in installing rooftop gardens. However, they did not install them as they wanted more financial and technical support from municipalities. In addition, people were afraid to install them due to the lack of architectural knowledge and awareness overall. The reasons for not using the public rooftops were "Unfavorable atmosphere because of the wrong people" and "Lack of green space access in the neighborhood." (Kalantari et al., 2016, p. 141). The most liked benefits were "Offer attractive view and increase visual aesthetic" and "Provide a new space for entertainment" (Kalantari et al., 2016, p. 142). Overall, this study showed that

people were interested in rooftops but were not ready to invest in installation for their own homes. (Kalantari et al., 2016).

In addition, in the study about green adaptations, the researchers found economic, social, and environmental benefits in green roof objects for big, highly urbanized cities. The evaluation was undertaken with household surveys in three wards of Dhaka, expert interviews, and the authors' personal experiences (Zinia and McShane, 2018). Rooftop gardens had very high social acceptance (85%) and economic feasibility and were commonly practiced in Dhaka, particularly among homeowners. Nevertheless, "Many respondents were unwilling to pay for green adaptation strategies even knowing their benefits" (Zinia, McShane, 2018, p 23). Although, some people were enjoying the incentives of such practice: fruits and vegetables.

As a study from India shows, there are many difficulties that people may encounter that prevent them from using and maintaining such gardens (Rani, K & Reddy, T & Shah, Swati, 2019). The problem of the lack of ground space for greenery and gardens is discussed, and rooftop spaces are shown as a sustainable alternative in metropolitan cities. The survey generally collected demographic information about the gardeners and their choices, age, gardening experiences, what they grow, and what problems and benefits they experience. The article uniquely provides suggestions for sustaining and upscaling rooftop gardens and ideas for the promotion of urban rooftop agriculture, such as different types of events like workshops and seminars that can train and demonstrate information and knowledge about urban agriculture and provide useful materials (Rani et al., 2019).

Among other difficulties people see in attending and using private or public green rooftop spaces are bad weather, setting, and landscape (Nguyen-Tran et al., 2020). They used fieldwork and simulation as their methods. "The study aims to understand the interaction between the

quality factors via the study of variations in the spatial settings, which affects the user experience." (Nguyen-Tran et al., 2020, p. 1045). In addition, the authors stated that tangible aspects such as the texture and height of the structures on the rooftop also affect people's perceptions and can make them like or dislike the space. (Nguyen-Tran et al., 2020).

Many areas are urbanizing quickly and dramatically influencing the regional ecology. "Rapid urbanization is a critical factor in modifying a city's spatial structure and influencing the biology and condition" (Aiholli & Bargavi, 2018, p 32). A Bangalore case study looks at rooftop farming through the lens of economic, environmental, and social sustainability, as "Rooftop farming offers many social, economic and environmental benefits to the high-density cities like Bangalore. It supports the local food production, reduces transportation energy and cost, reduces air pollution, improves personal and public health, and enhances community development." (Aiholli & Bargavi, 2018, p 32). The researchers conducted two surveys: one was a practitioner survey, and the other one was a non-practitioner survey. The authors also recommended some guidelines to improve rooftop cultivation practices, encourage more people to participate in rooftop farming and improve urban life. Interesting findings were among the practitioners' answers - for example, how they used the spaces apart from gardening - as play areas, sitting areas, and storage. Also, it was interesting to know that many people appointed gardening to a specialist, and some dropped gardening entirely due to maintenance issues (Aiholli & Bargavi, 2018). From the non-practitioner survey, the authors inferred a "lack of awareness among the people about rooftop farming which actually has a great potential in having a healthy life." The article states: "If the government initiates concentrating on rooftop farming incentives, all the incentives, the builders and the stakeholders would join hands to develop a sustainable city." (Aiholli & Bargavi 2018, p 37).

A group of researchers evaluated the importance of accessible green spaces and found that among the 556 respondents from 35 different countries and found that almost all participants knew what green roofs were, and a lot of them would love to have a green roof to "increase their access to vegetation," and many of them would have a preference of accessible ones to have an opportunity to read or relax read or relax, garden or exercise (Manso et al., 2021, p 4).

A questionnaire made by Zuzana Poórová and Zuzana Vranayová for their study *Green Roofs and Water Retention* (2016) included questions about people's perceptions of green roofs. The results of the survey showed that more than half of the respondents have no objections to green roofs, would like to have a green roof on the building they live, study, or work in, and agree that green rooftops are primarily built for sustainability.

Most studies about people's experience of green roofs are more focused on single-family homes or workplaces rather than multi-family apartment businesses. There is a lack of research that surveys the residents of multi-family houses. This thesis will contribute to this effort and give future researchers a start on studying the impact of rooftop spaces in Seattle and other cities.

## 2.4 MENTAL AND PHYSICAL IMPACT ON ROOFTOP GARDENS VISITORS

This research asks whether rooftop gardens have positive impacts on people's mental and physical health, and is guided by relevant literature making positive claims. Several studies show that rooftop gardens positively impact the mental and physical state. The study conducted by Triguero-Mas and colleagues (2020) shows compares the health of people with disabilities who spent time in gardens and those who did not. The researchers found that urban rooftop gardening positively impacts different people. They collected information about the quality of life of the residents - 54 gardeners and 43 non-gardeners; they also conducted interviews with participants and technicians and made field observations. They found a positive association: "Urban rooftop

gardening was associated with better personal development and suggested enhanced physical and emotional well-being, a sense of purpose, social inclusion, interpersonal relations, and general quality of life" (Triguero-Mas et al., 2020, p. 1). Such research can be helpful in the promotion of green, healthy, and equitable cities for different residents, and improve their quality of life (Triguero-Mas et al., 2020).

Another study that shows that rooftop gardening can be beneficial to people with mental health issues was conducted in Tokyo and showed the social aspect of rooftop green space usage (Kimura, Nishiwaki, & Miyata, 2008). The main respondents of the survey were gardening club members, their families, and the other residents who were not members but were using the rooftop gardens. Residents who did not have membership in the gardening club were divided into those who wanted social interaction and tended to be willing to join the club and those who do not want social interaction (Kimura, Nishiwaki, & Miyata, 2008). The majority of green roof users found mental health benefits, pleasure, and social development through visiting these spaces and communicating with others. In addition, club members showed satisfaction from participating in the gardening club.

Green spaces' positive impact is substantial: "Environmental stressors resulting from climate change will continue to exacerbate health and social disparities. Vulnerable populations will experience these associated health impacts more acutely" (Anderson et al., 2021, p. 14). The study about the health impacts of green infrastructure, conducted in Ontario, Canada, examined how green infrastructure impacted climate resilience, ecological connectivity, and community health. It consisted of 8 interviews with public health unit professionals and a survey of 36 green infrastructure volunteers and workers. The results showed that "when green infrastructure is both productive and publicly accessible, the benefits were significant for vulnerable populations".

These benefits included “increased social connectivity, skills development, and food security” (Anderson et al., 2021, p. 4). “It also leverages other co-benefits including stormwater matter management; air pollution abatement; biodiversity and pollinator support; and enhanced food security.” (Anderson et al., 2021, p. 14). In addition, the study shows that green infrastructure is a working strategy to mitigate the impact of environmental stressors, positively influence health equity issues, and implement the UN Sustainable Development Goals on a local level. This information allows for improving green infrastructures and future city policies (Anderson et al., 2021).

Ulrich and Simons researched stress-reducing properties of nature and its ability to help people restore “whereas many urban environments will hamper recuperation.” (Ulrich & Simons, 1991, p. 201). They used movie watching as the method for the research. One hundred twenty people watched a stressful movie and then watched color/sound videotapes of one of six natural and urban settings. The researchers checked their heart rate, muscle tension, skin conductance, and pulse transit time. People who watched the tapes with natural environments recovered faster. “Findings were consistent with the predictions of the psycho-evolutionary theory that restorative influences of nature involve a shift towards a more positively-toned emotional state, positive changes in physiological activity levels, and that these changes are accompanied by sustained attention/intake.” (Ulrich & Simons, 1991, p. 201) The findings convey that nature is vital in an urban setting, and green rooftops can be one of the reasonable nature-based solutions for the stress remedy of the residents.

We also can see an impact on people’s health during the COVID pandemic. Researchers found that  they discovered that nature therapy was more effective in treating mental health issues than physical exercise (though both were effective) and can act as preventive medicine in

preserving mental health during the COVID-19 crisis. The study shows that access to green space, such as a rooftop gardens, can help alleviate mental illnesses (Rajoo et al., 2021).

## 2.5 ACCESSIBILITY ISSUES OF ROOFTOP GARDENS

Not many authors talk about the accessibility aspect of green roofs, although accessibility should bean important consideration for any such space. Van Herzele (2003) states that green roofs have a problem with accessibility, as they are often located in buildings that only their residents can access. Their study assessed how many green spaces were accessible and how many were attractive to people in Belgium. They compared the results of the four cities, and found a deficiency. In Antwerp, Ghent, and Aalst, green space was available for about 35% of the population, while in Kortrijk, this rose to 95%. In addition, the level of the urban forest was lacking in three of the four cities (Van Herzele, 2003). Thus, even outside green roofs, other parks and open spaces are not easily accessible.

This research raises the problem of green space accessibility. Checking the existing buildings for green roof suitability is recommended; furthermore, the new buildings can be built with publicly accessible rooftops to promote better health in the city. As residential buildings tend to prohibit access to the general public, publicly accessible buildings could install intensive green roofs that the wider public could visit and enjoy. A team of researchers in Greece has conducted research to see how many roofs can be retrofitted using green roofs, and the analysis has shown that most of the buildings (700 buildings out of 1100) in the studied area were suitable for retrofitting, and structure and legislation allowed to install the green space on those buildings (Giannopoulou et al., 2019). Such analysis would be helpful for making Seattle greener and more sustainable.

# Chapter 3. Methods

## 3.1 RESEARCH QUESTIONS

The research questions that guide this thesis are:

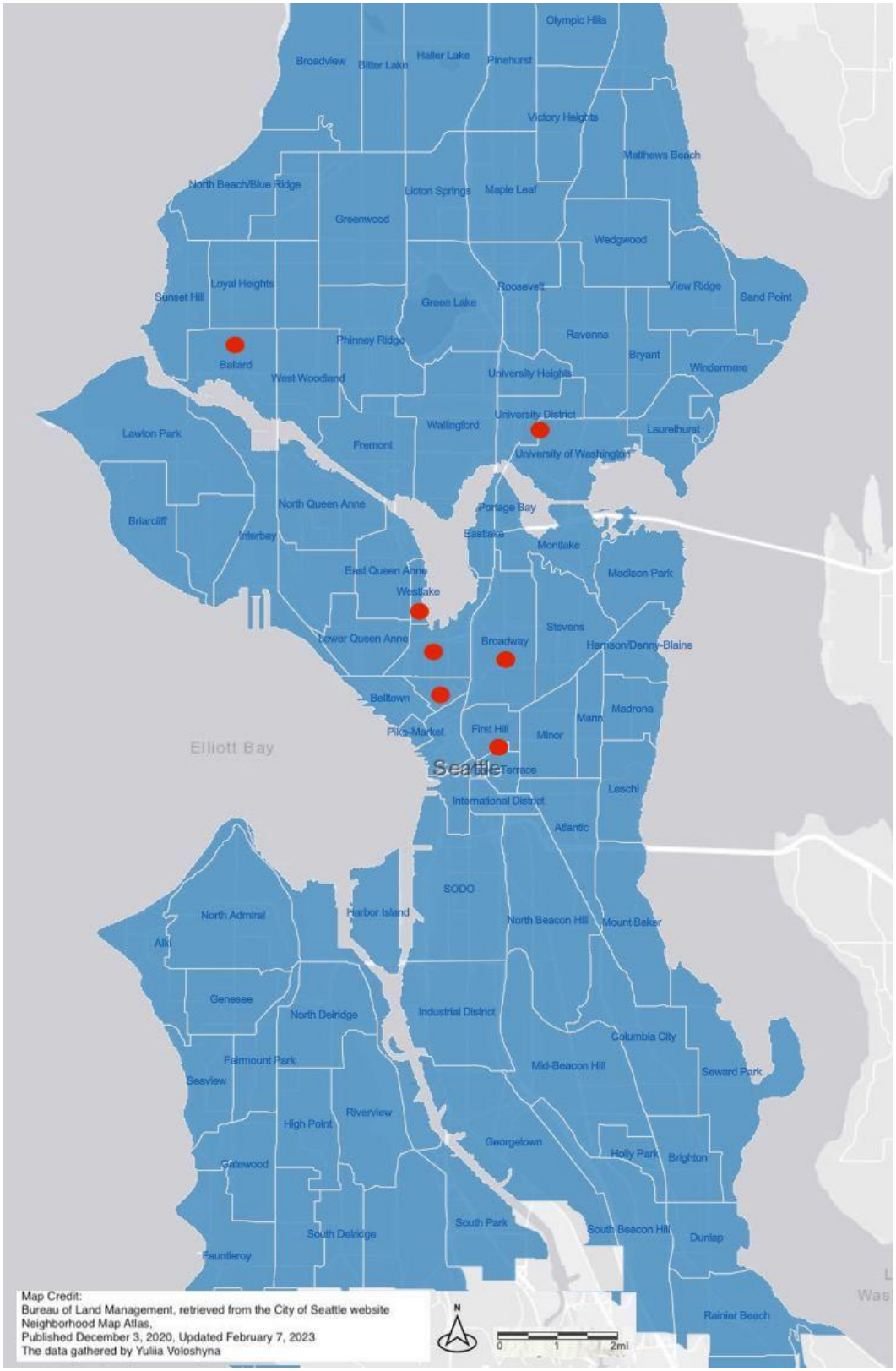
1. How do the users of the rooftop gardens in Seattle's multi-family apartment buildings experience them?
2. How do the users of the rooftop gardens n Seattle's multi-family apartment buildings benefit from them?

The answers to these questions will help planners, developers, designers, and architects better understand how people experience rooftop gardens, including what they like about them, and whether they feel better after visiting them and why. These findings could potentially influence future designs and policies in Seattle and beyond.

## 3.2 SURVEY

To answer the research questions, I conducted a survey of residents of buildings with rooftop gardens (attached in Appendix A). The survey respondents lived in Seattle and resided in multi-family apartment buildings with rooftop gardens. The survey was distributed online, and respondents were recruited via social media and paper flyers with QR codes, which were distributed throughout the city.

*Figure 3. Neighborhoods Where the Posters Were Distributed*



I used a modified snowball approach by asking participants to share the survey with anybody they knew who might live in such a building. A total of 64 people responded to the survey.

The survey began with images of green roofs to clarify what kind of rooftop garden the survey was interested in learning about. The survey included the following sections:

- Questions for the respondents who visit rooftop gardens in their apartment buildings.
- Questions for those who do not visit these spaces.
- Questions to collect demographic information.

People who answered that they did not visit the rooftop gardens in their apartment buildings were redirected to the demographic section after responding to the questions “What are your reasons for not visiting the rooftop?” and “Is it still of value to you, and in what way?” There were three respondents in this group. Next, the survey directed the 61 other respondents to the questions about their rooftop experiences. First, the survey asked how often people visit the rooftops; how they use them; whether they feel better after visiting them, and why; what are their favorite features and what is lacking. Respondents were then directed to demographic questions such as age, race or ethnicity, whether they rent or own their apartments, employment status, and the neighborhood they live in. The survey mainly included multiple-choice questions and allowed the respondents to choose one or several proposed options. It also had an open-ended option where the respondents could add their custom answer if the needed answer were not in the options list.

### 3.3 DESCRIPTIVE AND COMPARATIVE ANALYSIS

I then conducted both descriptive and comparative analyses of the results. The descriptive analysis provided multiple insights, gathered the information, provided a synoptic view of the

data, and prepared the data for further analysis to find out how participant demographics influenced the answers about rooftop gardens. The analysis also explored the responses of those who selected that their rooftop gardens lacked natural features, such as plants, gardening space and tools, and food gardens.

# Chapter 4. Survey Results

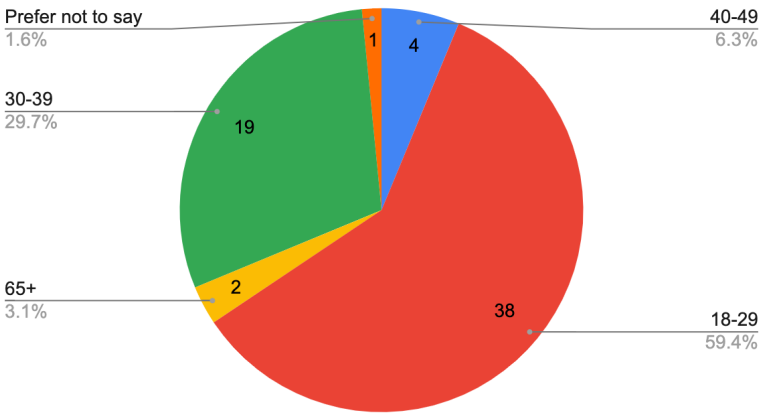
This chapter first provides an overview of all survey responses. It also shows demographic information about the respondents. Then, it highlights findings among different surveyed groups by comparative analysis and presents visualizations of the results.

## 4.1 DESCRIPTIVE ANALYSIS

### *4.1.1 Demographic Information*

Sixty-four survey responses were received. The biggest group of respondents, 38 people (59.4%), consisted of people aged 18 to 29 (see Figure 3). The next largest number of responders, 19 (29.7%), were aged 30-39. The age range of 40 to 49 included four participants (6.3%). There were no respondents in the group aged 49-65, and two from the 65+ age group. One person preferred not to say their age. This data allows us to see what preferences about rooftop gardens are associated with different age groups.

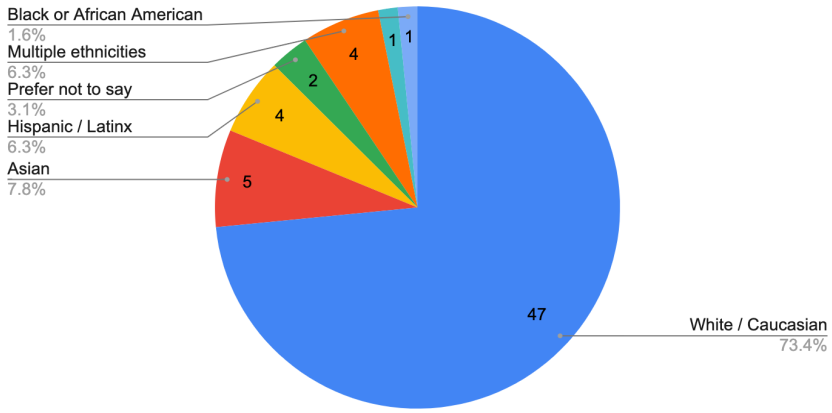
*Figure 4. Age Groups of the Respondents*




The majority of respondents, 47 people (73.4%), were White/Caucasian (see Figure 4). The second most common group was Asian, with five responses (7.8%). There were four people of

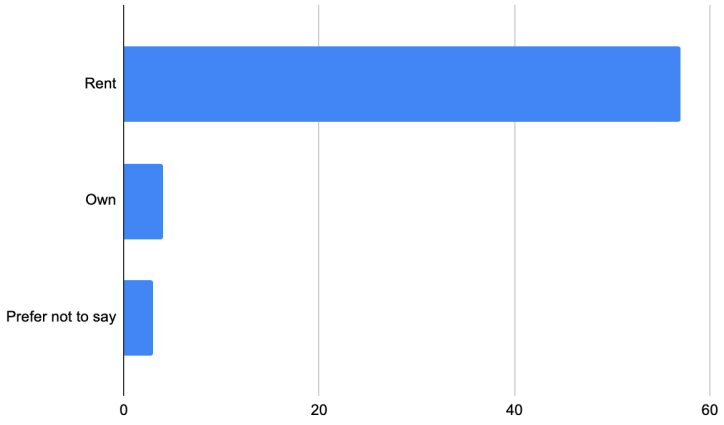
multiple ethnicities; three Hispanic/Latinx, and one Black or African American. Two preferred not to share their race and ethnicity.

*Figure 5. Race or Ethnicity of the Respondents*



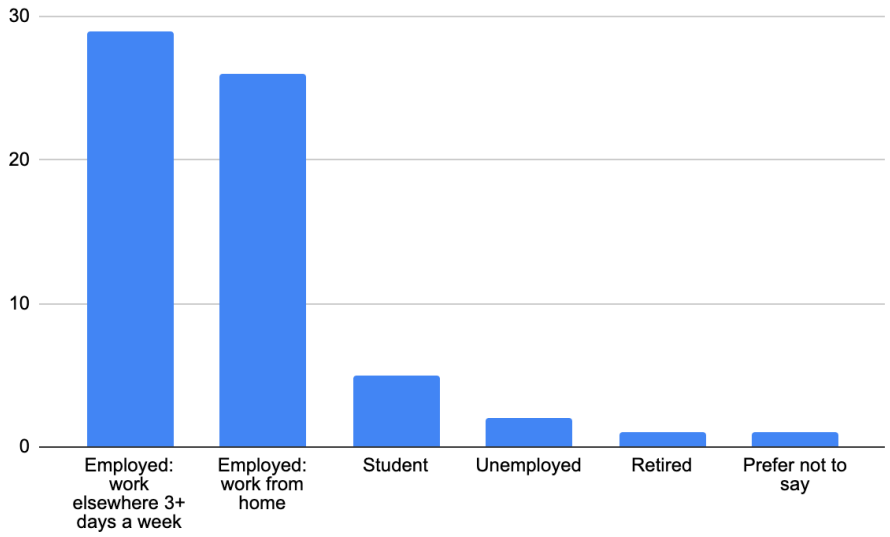

Most respondents (57 people or 89.1%) rent their apartments (see Figure 5). Four respondents owned an apartment with a rooftop garden in the multi-family apartment building. Two people preferred to keep this information private.

*Figure 6. Rent Versus Ownership of the Apartment in a Building with Rooftop Garden*



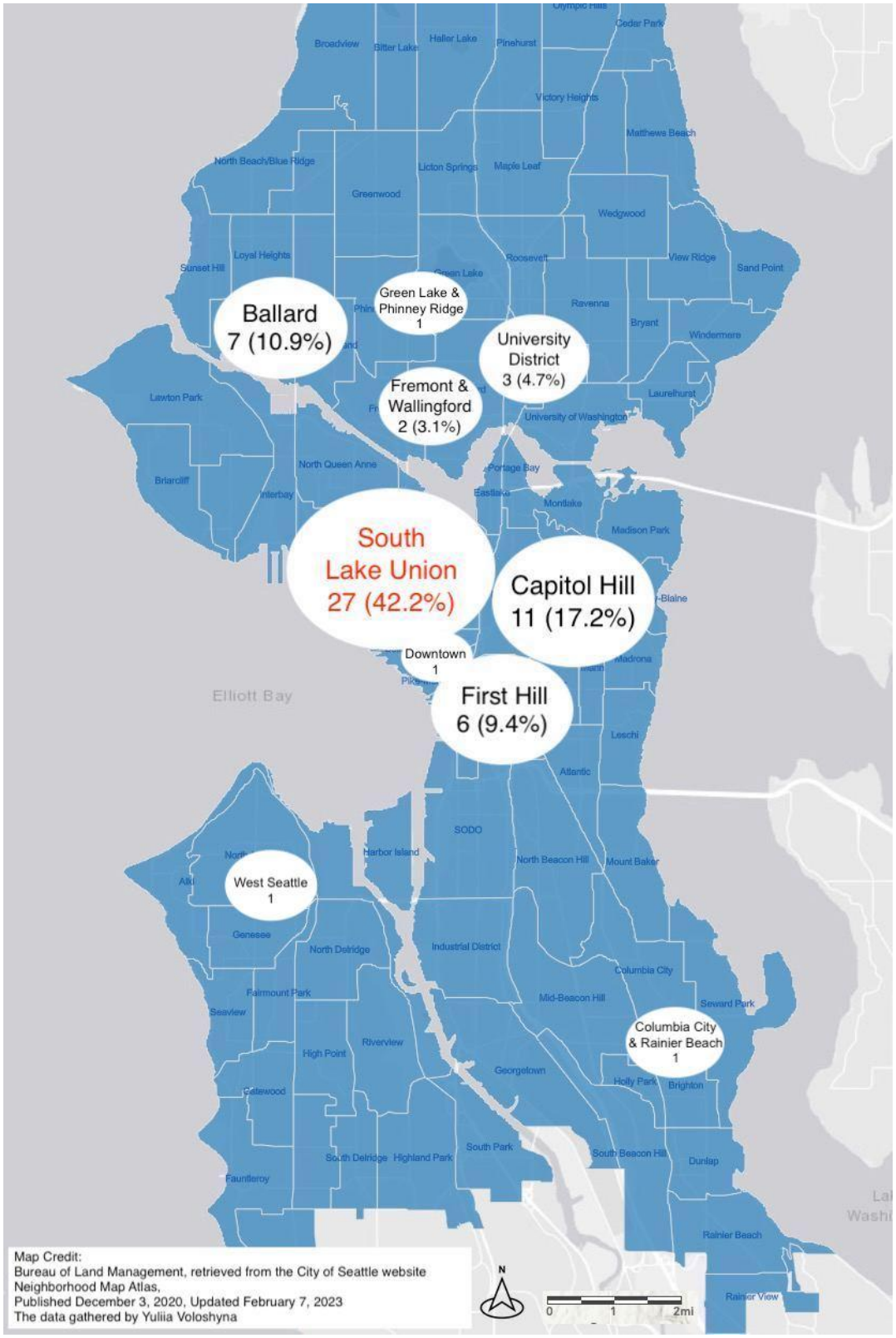

The survey highlights the diverse employment status of the respondents. 45.3 % or 29 respondents were employed and worked away from home 3+ days a week. A similar number worked from home (26, or 40.6%) ( Figure 6). Five people (7.8%), were students. Two unemployed people, one retired person, and two others preferred to keep this information private.

*Figure 7. Employment Status of the Respondents*




The survey was available to anyone in Seattle; however, most respondents lived in the South Lake Union neighborhood, 42% or 27 people (see Figure 7). This result was expected, as the area developed quickly and has many new buildings that likely include rooftop gardens (Young, 2008). A total of 11 respondents lived in the Capitol Hill neighborhood (17.2%), seven in Ballard (10.9%), and six in First Hill (9.4%). There were a small number of responses from other neighborhoods: three from the University District; two from the Fremont and Wallingford neighborhoods; one from the combined option of Columbia City and Rainier Beach; one from Downtown, one from West Seattle, and one from the combined option of Green Lake & Phinney Ridge. Three respondents chose the option “Other”.

*Figure 8. Neighborhoods with the Largest Number of Responses*



*4.1.2 Survey Answers about Rooftop Gardens*

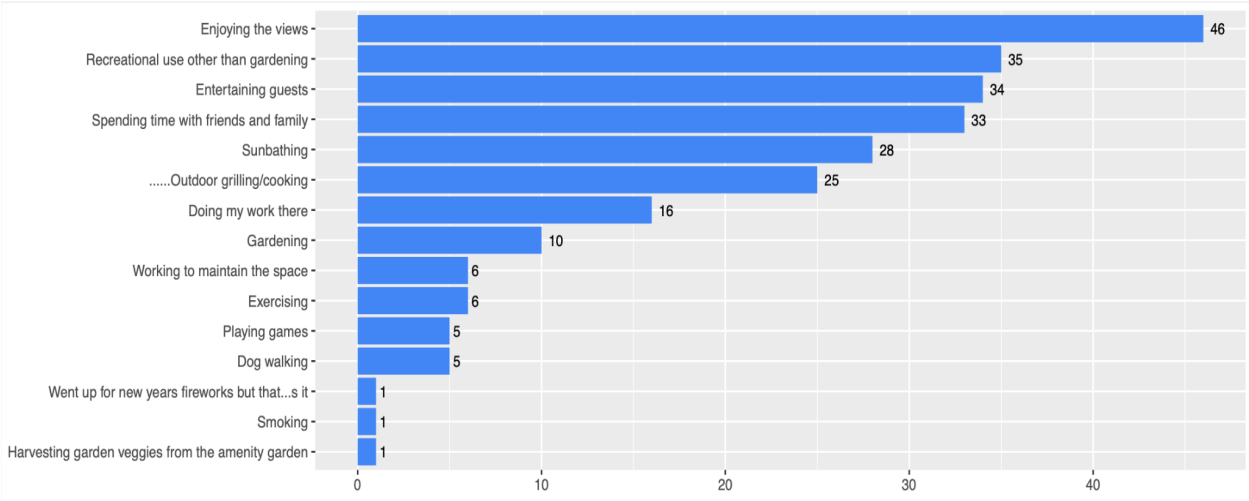
The survey begins with the question, "Do you visit the rooftop space in your apartment building?" By choosing "yes" respondents could take the whole survey about rooftop gardens. If the answer was "No," they were automatically moved to the question "What are your reasons for **not** visiting the rooftop?" and "Is it still of value to you, and in what way?" and then straight to the demographic section. Most respondents (61) selected the answer "Yes." Three respondents chose the answer "No." The reasons for not visiting rooftops were: "Do not garden" and "Other" (reason not specified), "Do not have time" and "Cannot access it." People could add a custom response in "Other" to specify their reason.

The respondents who did not visit the rooftop gardens were still asked whether they saw any value in these spaces. All three answered "Yes." One respondent specified, "If I had time to garden, I would probably enjoy tending to plants there." The people who responded that they used their gardens (61) had to answer six questions about these spaces. The first question was about the ways respondents used their rooftop gardens.

The survey provided twelve options and offered the option "Other" to specify other reasons for visiting the garden. It was possible to choose multiple options. The option "Enjoying the views" received the most votes (46) (see Figure 8). "Guest Entertainment" was the second most popular answer and received 34 votes. "Spending Time with Friends and Family" and "Recreational Use Other Than Gardening" received 33 votes each. "Sunbathing" was among the most popular responses and received 28 votes. In addition, 25 people answered that they used the rooftop for outdoor cooking. Perhaps surprisingly, fewer people selected "gardening" (10) or "maintaining the space" (6). People also used the space for doing their work (16), exercising (6), dog walking (5), and playing games (5). Unique answers received from respondents included

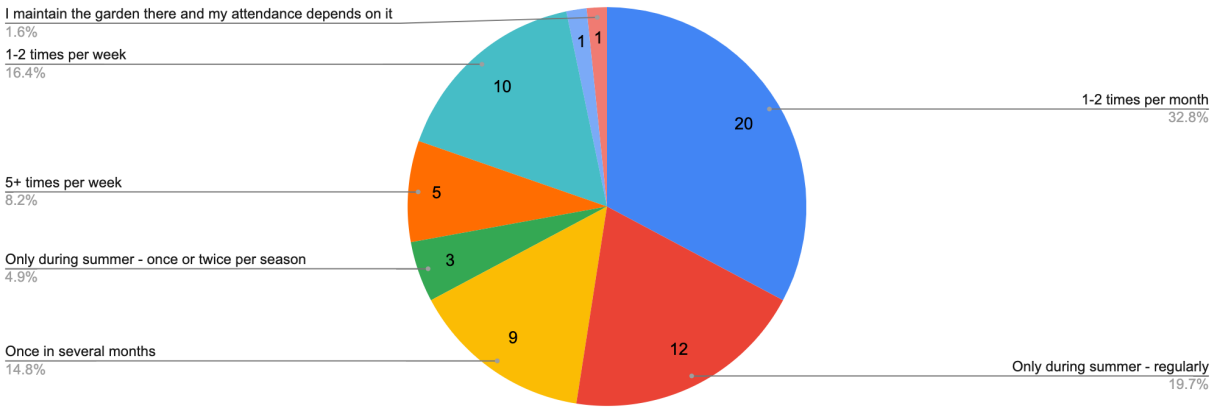
"went up for New Year's fireworks," "smoking," and "harvesting garden veggies from the amenity garden."

*Figure 9. How People Use Rooftop Gardens*




The survey asked people how often they visit the rooftop. The responses were diverse (see Figure 9). The most common answer was 1-2 times per month (20-32.8%). Other common answers were Only during summer to regularly (12-19.7%), 1-2 times per week (10-16.4%), and once in several months (9-14.8%). Other responses included 5+ times per week (5-8.2%); only during summer to once or twice per season (3-4.9%); one respondent chose option 1-2 times per week, and one respondent chose "I maintain the garden, and my attendance depends on it. Again, the answers are diverse and are potentially good candidates for comparative analysis with employment status or location data.

*Figure 10. Rooftop Attendance*

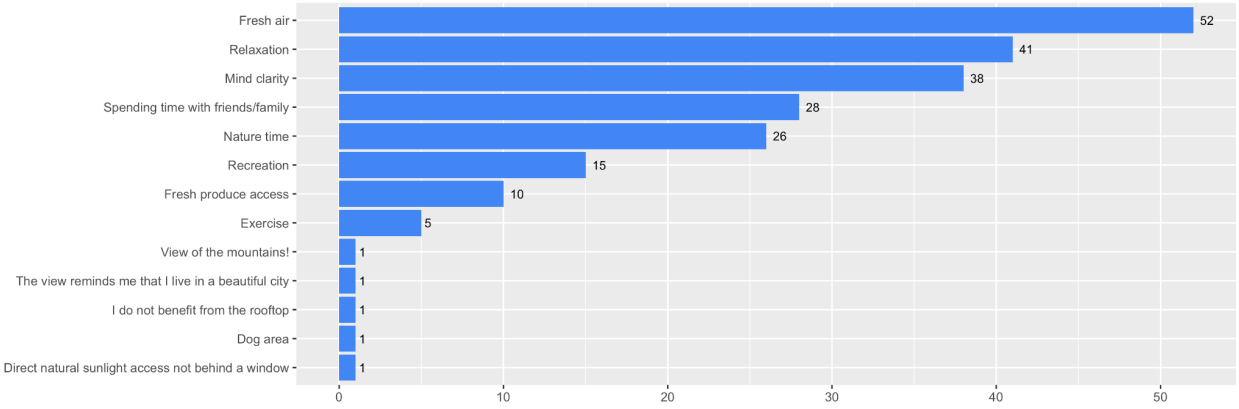



The next question asked the rooftop visitors whether they feel better after they visit the rooftop garden. According to the data, 58 respondents out of 61 feel better after visiting their rooftop spaces. Only three people answered that they did not feel better, and one of them added the reason, "No, because my building is NOT pet-friendly."This response was manually added to the "no" category. This survey question answers one of the questions of this research: whether people who use rooftop gardens benefit from them. As 95.1% of the respondents agree that they feel better after going there, these findings suggest that the answer to the research question is yes, people do benefit from the rooftops in their building apartments.

The next survey question asked to specify why people felt better after visiting rooftop gardens. There were nine options, and the respondents could choose up to nine and provide their custom answers in the section "Other." The most popular reasons why people felt better after going to the rooftop were fresh air (52), relaxation such as sunbathing or meditating (41), mind clarity (38), spending time with friends/family (28), and nature time (26) (see Figure 10). Other options were not as common as the previous ones; however, 15 people also chose the "recreation (playing games, hobbies, etc.)" option; 10 participants felt better because they had fresh produce access, and five people exercised there. One person answered that they did not benefit from this

rooftop space. Custom responses mentioned in "Other" were "view of the mountains!", "direct natural sunlight access not behind a window," "dog area," and "the view reminds me that I live in a beautiful city."

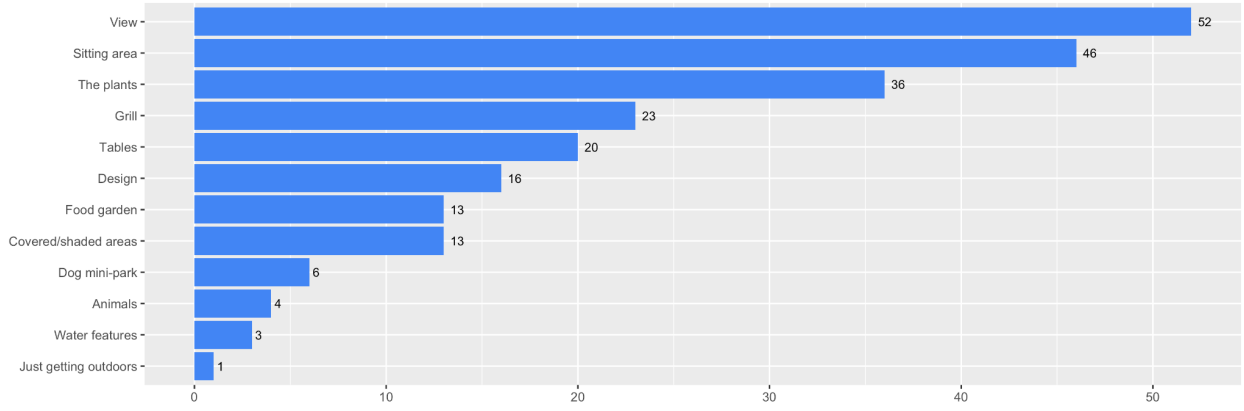
*Figure 11. Why People Feel Better After Visiting Their Rooftop Gardens*




The next question asked about the most favorite features of rooftop spaces in people's houses. One of the findings is that people's favorite feature is view; 52 people choose this option in the question (see Figure 11). The second most popular option was the sitting area (46 out of 61). Another favorite option was "the plants" (36), which is surprising because only ten respondents chose gardening as a reason for visiting the space in the earlier survey question Moreover, 13 responded that the food garden was their favorite feature. It could mean that people still enjoy greenery on the rooftop but did not like participating in gardening activities. A grill was a favorite rooftop feature for 23 respondents; 20 people liked the existence of tables; 16 people enjoyed their rooftop design as a whole; 13 visitors favorited the shelters or the areas that are covered; the mini dog parks received six votes; four people favorited the presence of animal life, and three respondents liked the water features on their rooftops. One custom answer was "just getting outdoors," which is more a reason why a person likes getting up to the rooftop. This person uses the rooftop garden for getting outdoors, and it shows that people might sometimes

substitute rooftop spaces for ground-level parks. This survey question had some limitations, as not all the mentioned features exist on every rooftop, and some are rare across any rooftops. These include food gardens, mini dog parks, or water features.

*Figure 12. Respondents' Favorite Rooftop Features*

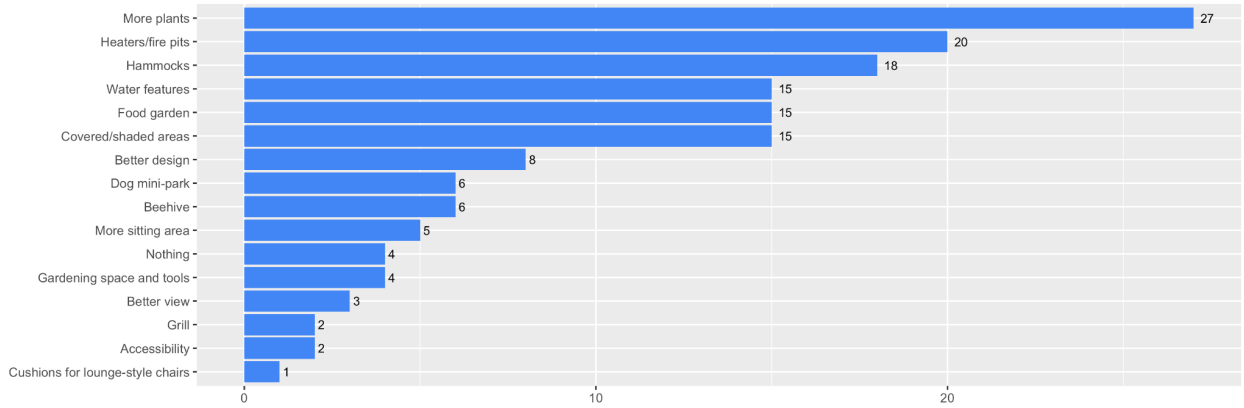



The last survey question asked, "What needs to be added to your rooftop?" This question can provide policymakers and residential building designers with the most valuable information. It included 15 options plus an option to choose "Other" and give a personal response. Twenty-seven people wanted to see more plants on their rooftop gardens (see Figure 12); 20 respondents wanted fire pits or heaters; the hammocks option was another common answer (18); 15 people wanted to see water features; another 15 respondents chose food garden; 14 people wanted more shaded or covered areas. There were some votes for better design overall (8), beehives (6), a mini dog park (6), gardening space and tools (4), grill (2), accessibility (2), and better view (3). Nobody voted for more tables. Two participants responded that nothing needed to be added by adding their custom answer and both wrote "nothing" in "Other." The other two added their custom responses with the same meaning: "nothing, got most of those things - it is a nice roof," and "nothing, I am satisfied with the features on my roof." I combined all these answers into the "nothing" category for future analysis. Among other custom answers, rooftop

visitors also said they would like to see “shelter from the sun.” Because this is  the same as the covered/shaded areas option, we moved it into the covered/shaded areas and “cushions for lounge-style chairs.”

This question shows what needs to be added on most rooftops (with “more plants” as the clear preferred option), which can be helpful information for rooftop planning.

*Figure 13. What People Would Like to Add to Their Rooftop Gardens*




## 4. 2 COMPARATIVE ANALYSIS

I performed additional analysis by representing the results in split bar plots. A closer look at the respondents’ age and employment location versus the rooftop features they chose provided valuable information. I omitted the age answers of three respondents who did not give any responses about rooftop garden features and answered that they do not visit the rooftops in their apartment buildings; the analysis is based on 61 responses. The analysis also includes the response of a person who did not prefer to report their age; however, the bar chart includes their responses. Nevertheless, this data unit is an outlier. I also included the custom answers in the charts. These unique responses provide valuable insights into how people experience their rooftops. The answers of people who responded that they do not feel better after visiting the rooftop gardens are also included in most parts of the analysis, as these respondents also reported

the reasons why they feel better, however, answering that they **do not** feel better. Furthermore, they provided information on their favorite features and other pieces of important data.

*4.2.1. Responses Varied by Age*

I separated age ranges into two groups: 18-29 and 30+, as the majority of the survey respondents were from the 18-29 age range, and to have a more informative analysis, the range options 30-39, 40-49, 40-65, and 65+ were merged into one group to make the groups more even. This regrouping resulted in 38 people in the 18-29 age group and 22 people in the 30+ age group. The research provides this data in graphs to better understand the results. For simplification and statistical purposes in this research, the two age categories received the names "adults" (18-29-year-olds) and "older adults" (30+-year-olds).

Starting with the analysis of the response to "How do you use [the rooftop garden]?", we can see that "enjoying the view" was a popular answer among both groups. It was the most popular answer overall, with 77 and 75% of respondents, respectively (see Figures 13.1 and 13.2). Among the other most popular ways of usage for the adults group were: recreational use other than gardening (25 respondents or 70%), while for older adults, it was just 10 respondents (or 42%); entertaining guests (22 respondents, or 61%); sunbathing and spending time with friends and family were selected an equal number of times (18 respondents, or 50%); outdoor grilling and cooking were also among popular usages for the adults (16 respondents, or 44%). For the adult group, the second most popular usage is spending time with friends and family: it was selected by 82% of all the respondents or 18 people of the age group 30+. This option is in fourth/third place for the adults group, sharing it with the sunbathing option that was less popular among older adults and was selected ten times versus 18. Gardening was not popular among

either of the groups. The reason for it is that not all rooftops have gardening spaces accessible for the residents.

*Figure 14.1. Age Versus How People Use Rooftop Gardens (%)*

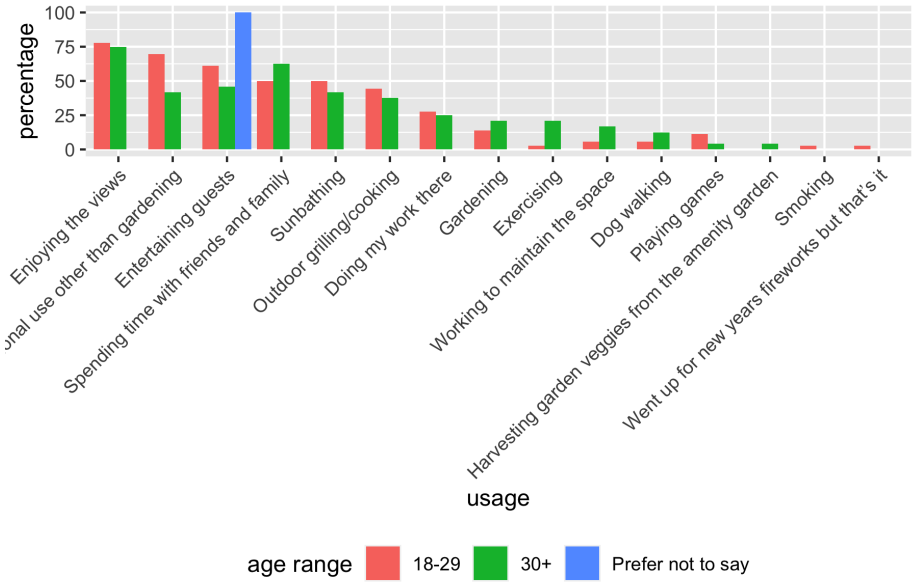
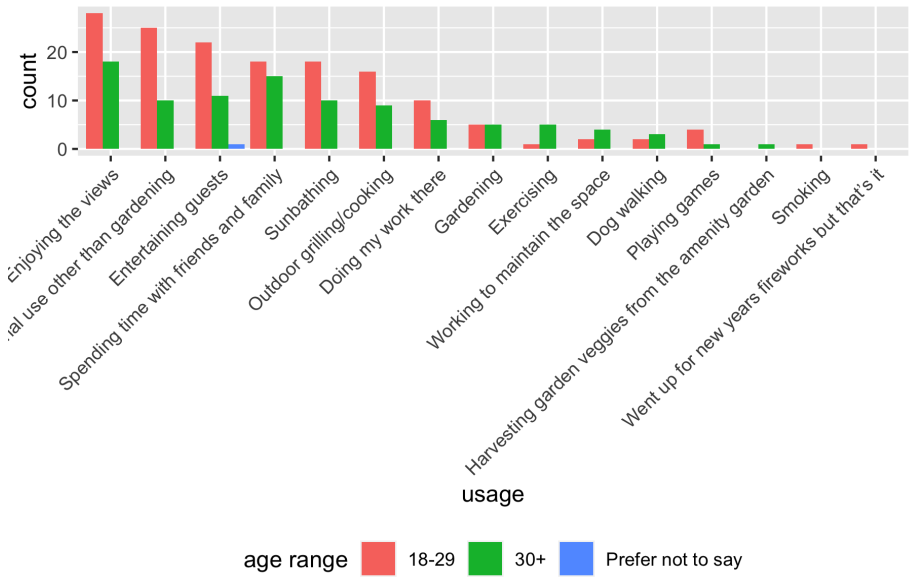



*Figure 14.2. Age Versus How People Use Rooftop Gardens (count)*




Another analysis compares the answers of the same age groups to the question of whether the respondents felt better after visiting their rooftop gardens. Fresh air was the most common

answer among adults (33 respondents, or 91%) and older adults  19 respondents, or 79%) (see Figures 14.1 and 14.2). This finding is interesting but logical: outdoor settings provide access to fresh air that benefits human health (Twohig-Bennett, & Jones, 2018). However, the graph shows that more people in the 18-29 age range see mind clarity as the reason for better well-being after visiting the rooftop (69% versus 54%). Another interesting result is that in the question about usage, the option "spending time with family/friends" was one of the most common, however in the question "Why do you feel better after visiting your rooftop ?", this option was less popular but still selected more often by the adult category. About 54% of the surveyed older adults reported that this makes them feel better. In comparison, for adults , this percentage is 39%. Fresh produce access was selected only by six older adults and four adults . Many other options' results are similar between groups and show no significant differences; for instance, nature time was selected by 46% of adults  and 41% of older adults, respectively; recreation was equally chosen by 25% of respondents of both groups; relaxation was selected by 70% of adults  and 67% of older adults, which was the second most popular choice among both age categories.

*Figure 15.1. Age Versus Why People Feel Better after Rooftop Garden Visit (%)*

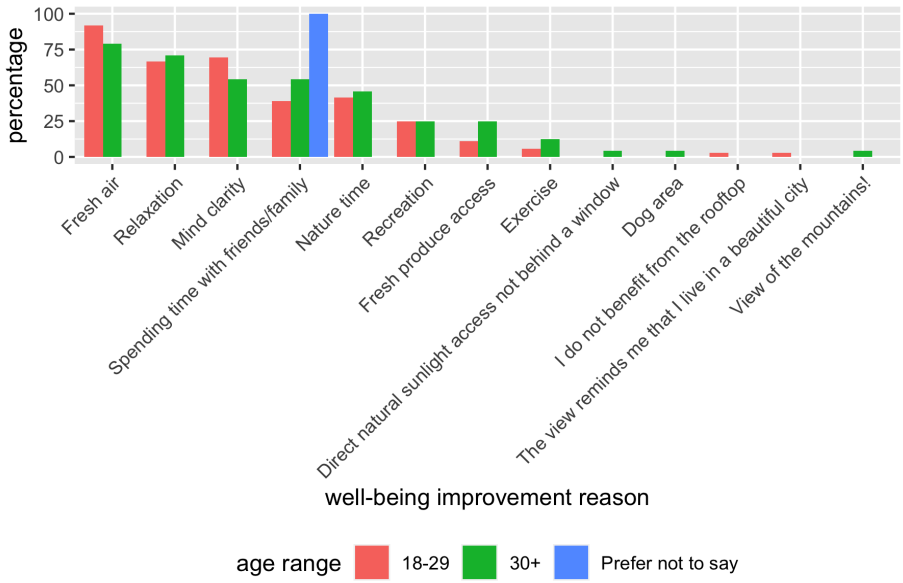
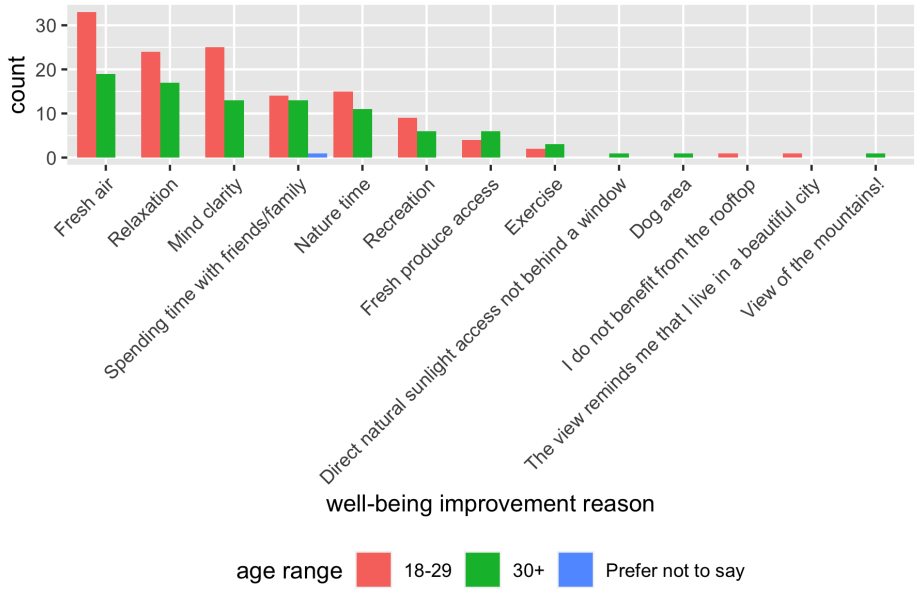


*Figure 15.2. Age Versus Why People Feel Better after Rooftop Garden Visit (Count)*




The next analysis tool that can bring helpful findings about people's experiences of rooftop gardens is the split bar graph for age and favorite features. Here, the chart shows that, again, the view is the most popular feature in rooftop gardens (86% of adults and 83% of older adults); however, this also shows that plants are appreciated by 66% of adults and (50% of adults, as well as sitting areas, enjoyed almost equally (77% of adults and 75% of older adults) (see Figure 15.1). Until this point, the analysis showed that nature components were not the most important rooftop feature, as gardening was not selected often in the usage question; custom responses mentioned "harvesting veggies" only once. Nature time was not among the most popular answers to the question about better well-being. However, this analysis has shown that plants are important for many rooftop users, primarily for younger ones. Five people under 30 and eight aged 30+ selected food gardens (see Figure 15.2). It gives room for further analysis, where we can compare the answers to the question, "What needs to be added to your rooftop?" versus Favorite features. Before doing so, I generated a plot for the things people of different ages want to be added to their rooftops, which is discussed further.

*Figure 16.1. Age Versus Favorite Feature (%)*

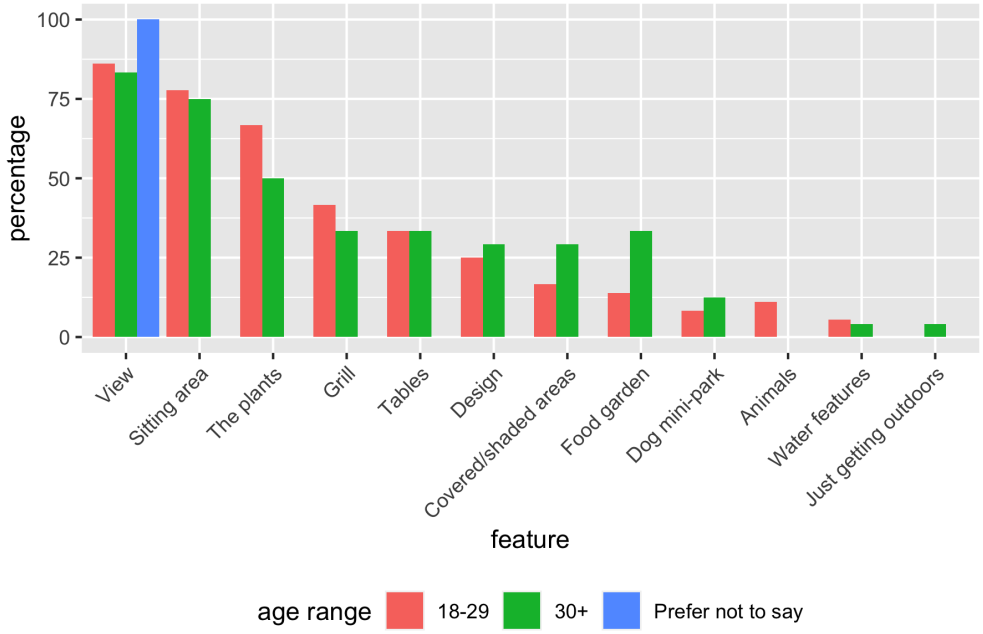
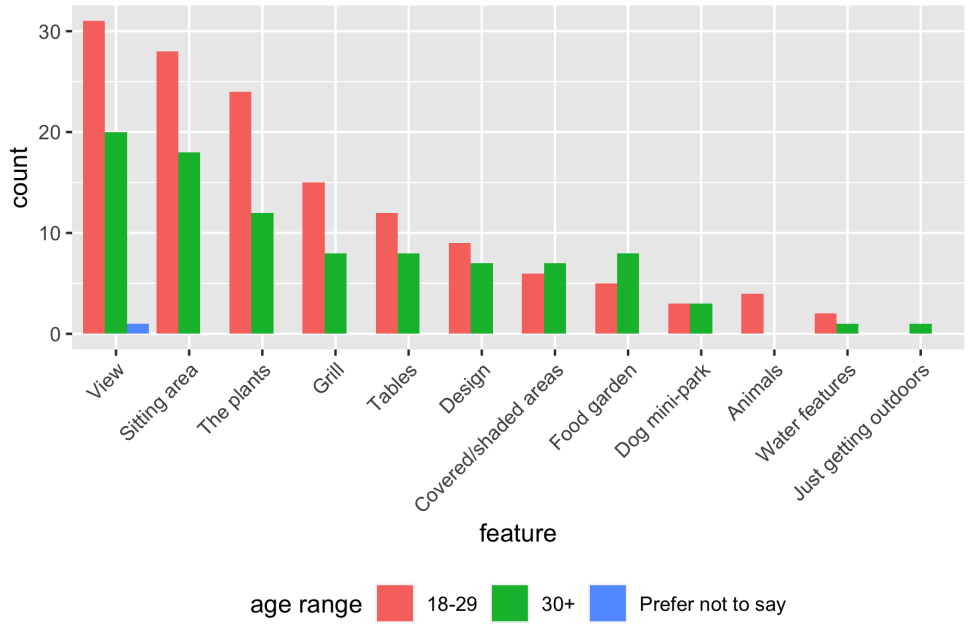



*Figure 16.2. Age Versus Favorite Feature (Count)*




The analysis of the missing features on the respondents' rooftops ("What needs to be added to your rooftop?") shows that the most popular option is "plants"; however, only 14 adults and

13 older adults selected this option (see Figure 16.2). Furthermore, the analysis shows that among surveyed people of younger age, there are fewer respondents who selected plants in this question: 38%, and 54% of older adults (see Figure 16.1). Interestingly, in the previous question about favorite features, the graph showed that plants were a favorite feature for 66% of adults and (50% of older adults. In addition, the plants are a favorite feature of the rooftops for more people in the 18-29 range; however, a higher percentage of people of age 30+ prefer to have more plants on their rooftop gardens.

*Figure 17.1. Age Versus What Needs to Be Added to the Rooftop Garden (%)*

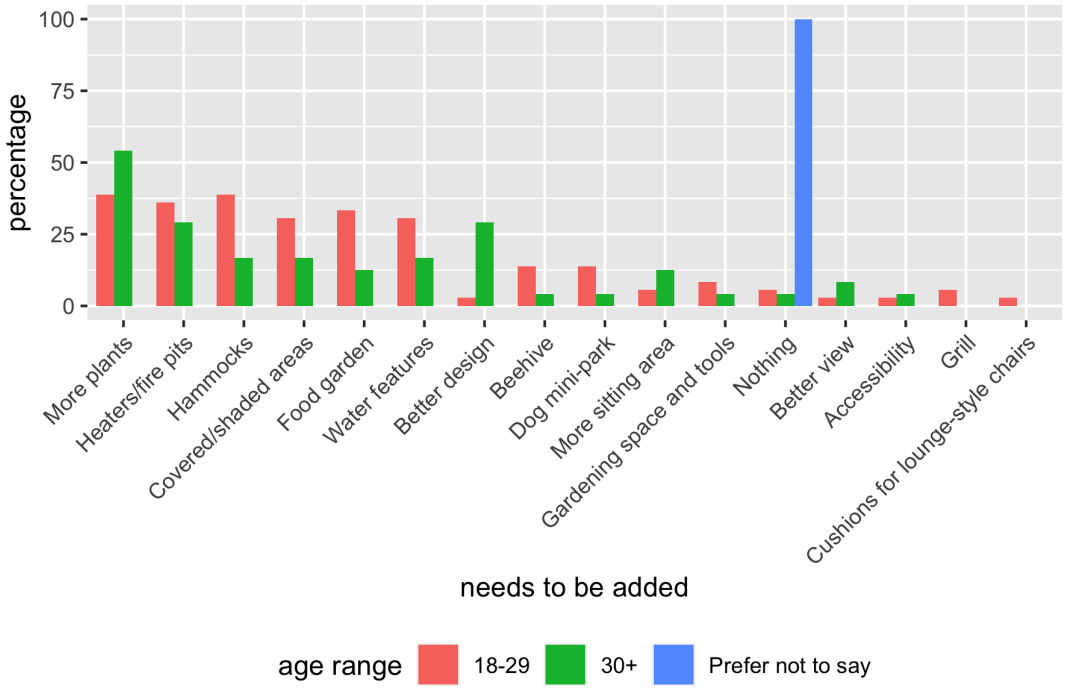
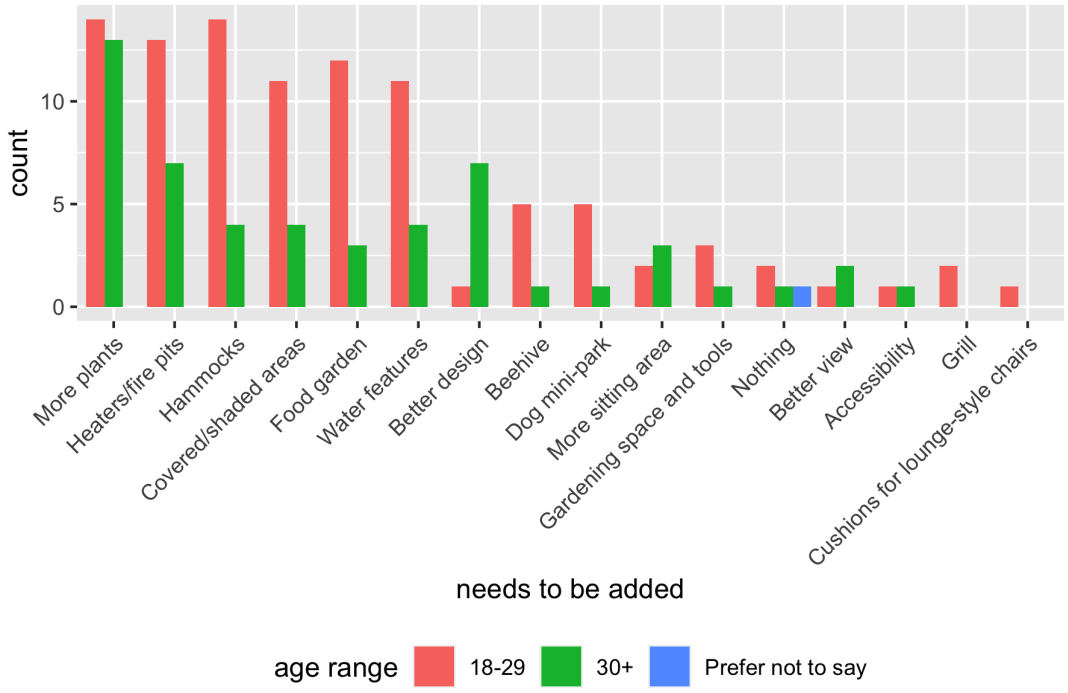


*Figure 17.2. Age Versus What Needs to Be Added to the Rooftop Garden (Count)*




The comparative analysis graphs for age versus favorite features and age versus what people would like to add to their rooftops have shown visual differences in answers between the two age groups. However, it is not clear if they are statistically different due to a different number of responses among the two age groups.

Three unclear variables for the question about favorite features were: plants, design, and food garden. To see if there if the responses correlate with age, I run a chi-square test of independence. I examined the relation between the favorite features of adults and older adults. N = 60 (the "prefer not to say my age" response was omitted). The relation between all these variables was significant, as the p-value was more than 0.05 for all three variables: 0.3 for plants, 0.95 for design, and 0.1 for food gardens.

*Table 1.1. Distribution of Responses for "The Plants" Option of "What Is Your Favorite Feature?" Question Depending on Age of Respondent*

| | The plants | |
|---|---|---|
| **What is your age?** | **Not Selected** | **Selected** |
| **18-29** | 12 ( 33.3%) | 24 ( 66.7%) |
| **30+** | 12 ( 50.0%) | 12 ( 50.0%) |
| **Total** | 24 ( 40.0%) | 36 ( 60.0%) |

$X^2 = 1.0446$ $df = 1$ $p = .3068$

*Table 1.2. Distribution of Responses for "Design" Option of "What Is Your Favorite Feature?" Question Depending on Age of Respondent*

| | Design | |
|---|---|---|
| **What is your age?** | **Not Selected** | **Selected** |
| **18-29** | 27 ( 75.0%) | 9 ( 25.0%) |
| **30+** | 17 ( 70.8%) | 7 ( 29.2%) |
| **Total** | 44 ( 73.3%) | 16 ( 26.7%) |

$X^2 = 0.0036$ $df = 1$ $p = .9525$

*Table 1.3. Distribution of Responses for "Food Garden" Option of "What Is Your Favorite Feature?" Question Depending on Age of Respondent*

| | Food garden | |
|---|---|---|
| **What is your age?** | **Not Selected** | **Selected** |
| **18-29** | 31 ( 86.1%) | 5 ( 13.9%) |
| **30+** | 16 ( 66.7%) | 8 ( 33.3%) |
| **Total** | 47 ( 78.3%) | 13 ( 21.7%) |

$X^2 = 2.1645$ $df = 1$ $p = .1412$

Three unclear variables for the question about the features people would like to add were: more plants, better design, and a food garden. N = 60 (the "prefer not to say my age" response was omitted). For the "more plants" and "food gardens," options p-value is more than 0.05 - 0.4 for plants and 0.1 for food gardens. However, there is no significant relation for the "design" option, as the p-value is 0.01 and less than 0.05.

*Table 2.1. Distribution of Responses for "More Plants" Option of "What Needs to Be Added?" Question Depending on Age of Respondent*

| | **More plants** | |
|---|---|---|
| **What is your age?** | **Not Selected** | **Selected** |
| **18-29** | 22 ( 61.1%) | 14 ( 38.9%) |
| **30+** | 11 ( 45.8%) | 13 ( 54.2%) |
| **Total** | 33 ( 55.0%) | 27 ( 45.0%) |

$X^2 = 0.8109$ $df = 1$ $p = .3679$

*Table 2.2. Distribution of Responses for "Better Design" Option of "What Needs to Be Added?" Question Depending on Age of Respondent*

| | **Better design** | |
|---|---|---|
| **What is your age?** | **Not Selected** | **Selected** |
| **18-29** | 35 ( 97.2%) | 1 ( 2.8%) |
| **30+** | 17 ( 70.8%) | 7 ( 29.2%) |
| **Total** | 52 ( 86.7%) | 8 ( 13.3%) |

$X^2 = 6.5445$ $df = 1$ $p = .0105$

*Table 2.3. Distribution of Responses for "Food Garden" Option of "What Needs to Be Added?" Question Depending on Age of Respondent*

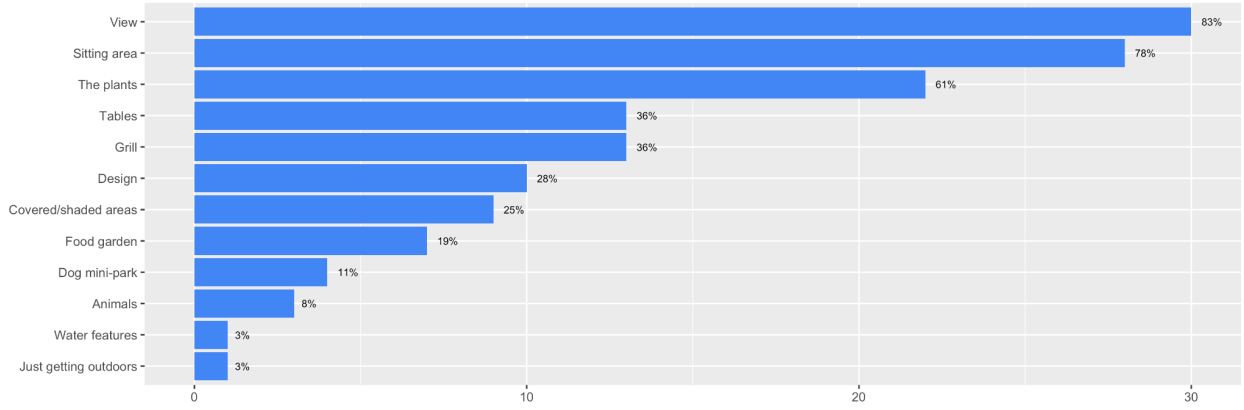
| | Food garden | |
|---|---|---|
| **What is your age?** | **Not Selected** | **Selected** |
| **18-29** | 24 ( 66.7%) | 12 ( 33.3%) |
| **30+** | 21 ( 87.5%) | 3 ( 12.5%) |
| **Total** | 45 ( 75.0%) | 15 ( 25.0%) |

$X^2 = 2.3148$ $df = 1$ $p = .1281$

*4.2.2. Missing Nature Components Versus Favorite Features*

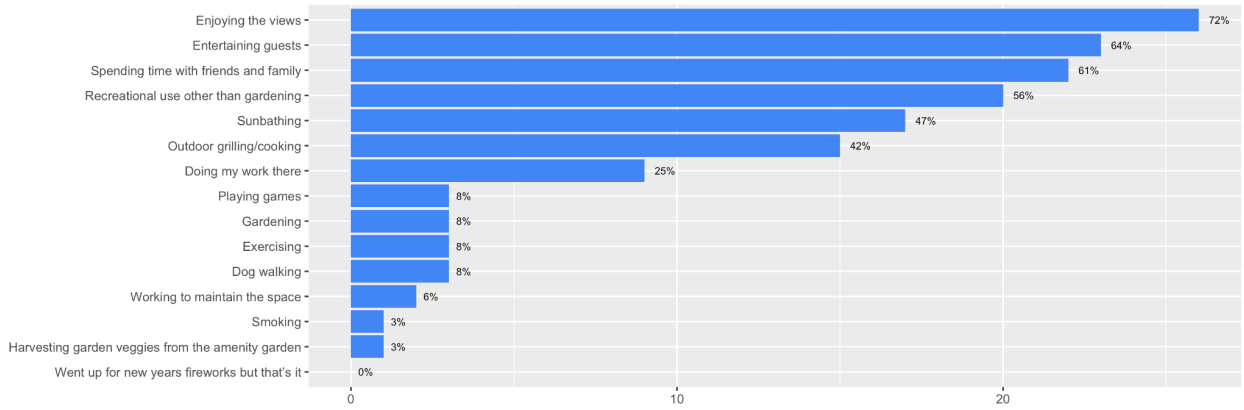
For this analysis, we created a bar chart and selected only the respondents who liked at least one of the following features answering the question, "What needs to be added to your rooftop?": food garden, gardening space and tools, and more plants (36 respondents). Then, respondents' favorite features of their rooftop gardens were explored, as well as the ways the respondents used them. Most of the respondents who answered that they would like to see more plants, food gardens or gardening space, or tools (further: nature features) also listed plants as their favorite features (22 respondents, or 61%) (see Figure 17). 36 out of 61 respondents from the whole survey chose plants as their favorite feature. This result suggests that people who select plants as their favorite feature of rooftop gardens would like to see more of them on their rooftops. The food garden was a favorite feature for 13 respondents (19%) from the whole survey, seven of which were among people who mentioned that their rooftop lacked nature features.

*Figure 18. Favorite Features of the Respondents Who Would Like to Have More Nature Features*




Among the ways of use, there are just three answers (8%) for "gardening" (see Figure 18) out of ten responses among all participants. We can hypothesize that people who lack natural features cannot respond that they use their rooftops for gardening, as they do not have gardens and tools for gardening. However, there are not enough responses and evidence for it. This finding can be material for future research. It can also indicate a limitation of the survey design that could not address all the inventory of the roofs of each respondent.

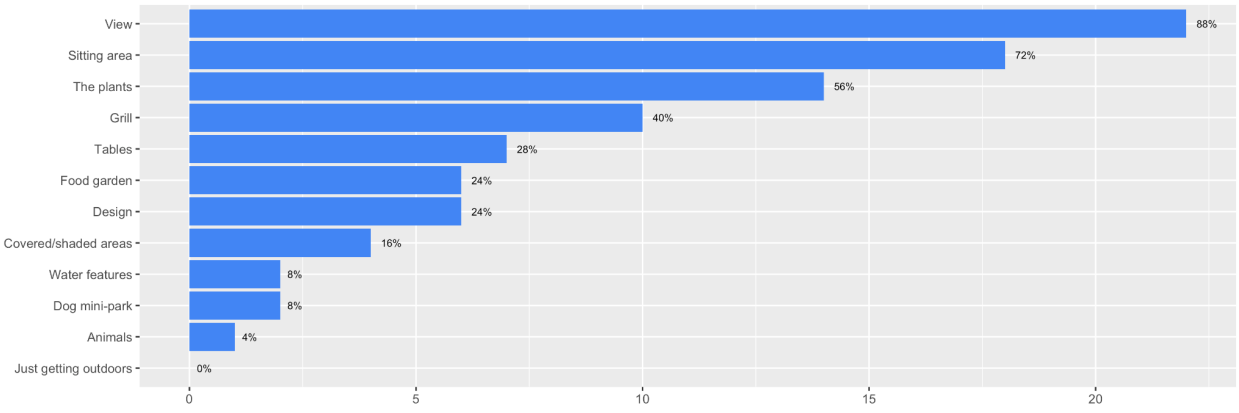
*Figure 19. How the Respondents Who Would Like to Have More Nature Features Use Rooftop Gardens*




Furthermore, I analyzed the responses of the group of people who did not choose any of the following features answering the question, "What needs to be added to your rooftop?": food garden, gardening space and tools, and more plants (25 people). The view is the most popular

option for both groups, who chose the nature features and who did not. The sitting area is also in second place for both groups; the first group chose this option more - 28 responses (78%), compared to the second group - 18 responses (72%). 14 (39%) respondents have chosen plants as their favorite feature, not willing to have more of them on their rooftop gardens. Only four respondents (16%) who do not want to see more nature features chose covered/shaded areas, only seven (28%) chose tables, versus nine (25%) responses for covered/shaded areas, but 13 (36%) for tables among people who preferred to see more plants, food gardens or gardening space and tools on their rooftops. Food gardens were a favorite feature for 19% of respondents who wanted to see more nature features and for 24% of the respondents who did not.

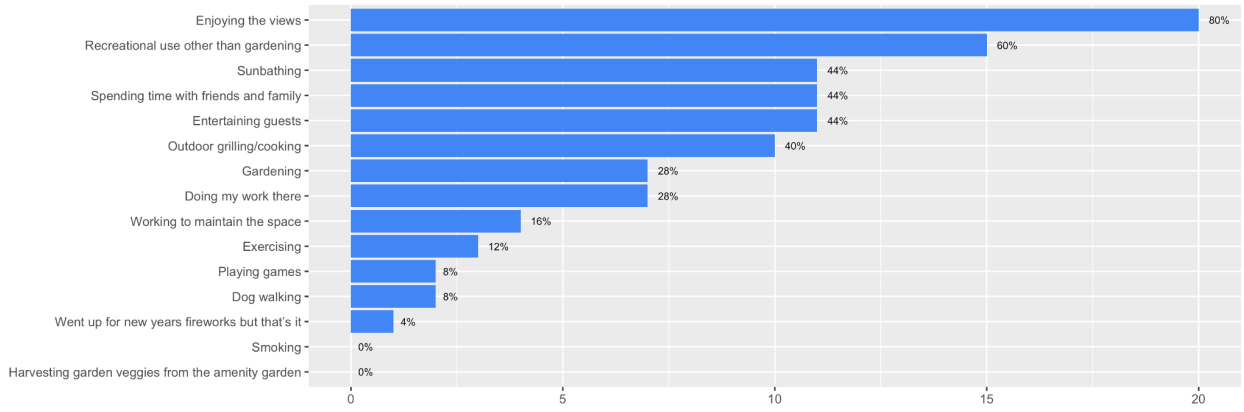
*Figure 20. Favorite Features of the Respondents Who Did Not Choose That They Would Like to Have More Nature Features*




Further analysis shows that the order of the most frequently chosen features differs; however, there are no significant differences between the percentage of people from both groups who chose these features. However, some differences are more significant; for instance, only 44% of respondents who did not choose that any nature features needed to be added to their rooftops use rooftops to spend time with their friends; 51% of the respondents who wanted to see more nature features chose this way of use. Another significant difference is the percentage of responses for

the “working to maintain space” - 16% for the people who did not want more nature features and 6% for those who did. The most valuable finding is that 28% of the respondents who did not want more nature features used their rooftop gardens for gardening; however, only 8% of the respondent who wanted to see more plants, food gardens, or gardening spaces and tools selected this option. It is a possible indicator of the missing gardening features on the rooftops of those who do not garden and want to see more gardening features or plants.

*Figure 21. How the Respondents Who Did Not Choose That They Would Like to Have More Nature Features Use Rooftop Gardens*



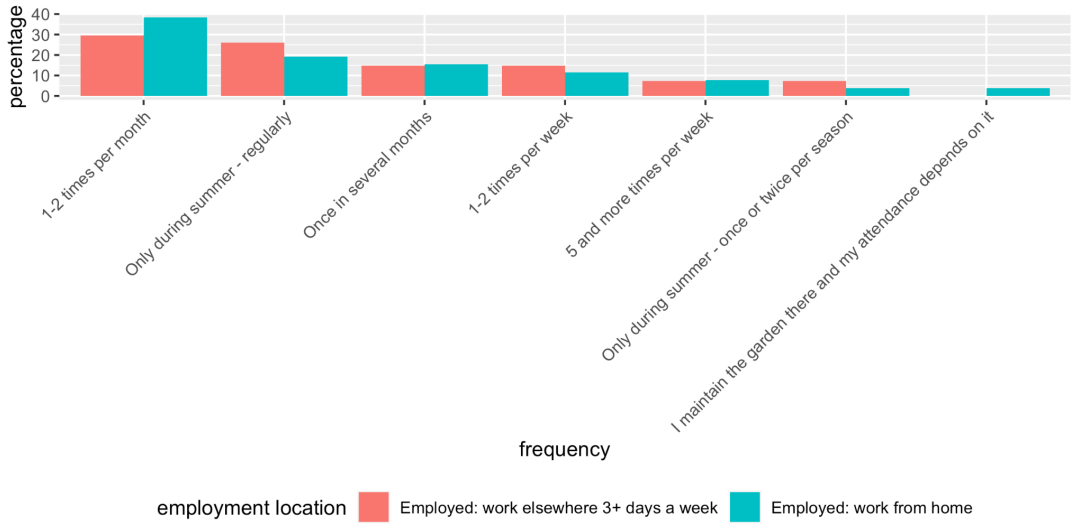

### *4.2.3. Responses Varied by Employment Location*

The next set of plots provides insights on variation by employment location. The analysis allows us to compare how people working from home and working from elsewhere 3+ days a week use the space. The research also provides descriptive analysis, including the participants that self-reported as retired (one), students (five), and unemployed (two), and one person who preferred not to report their employment location; however, the number of answers of these types was not sufficient for comparative analysis, so the analysis concentrates on two groups: people working from home and people working from elsewhere 3+ days a week. Also, this analysis

provides information about people who likely spend different amounts of their time at home and use the rooftop differently.

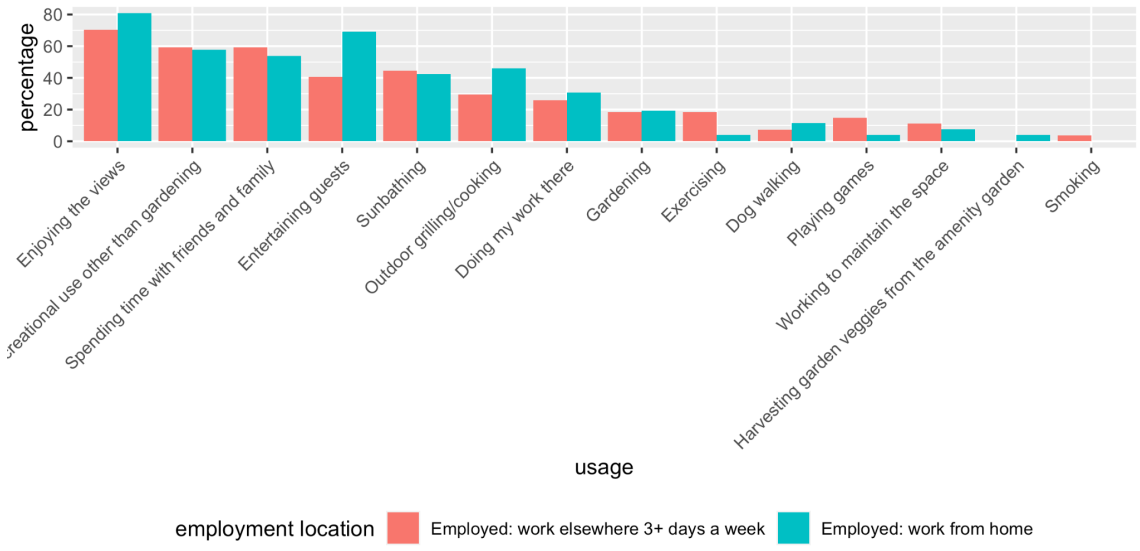
The dataset includes 53 responses, 26 working from home and 27 working from elsewhere 3+ days a week, as we also omit the responses of those who answered that they did not visit the rooftop. First, I compare how often both groups visit rooftop gardens. As the graph below shows (see Figure 19), the most common response for both groups is "1-2 times per month". 38% of people who work from home selected this option, while 30% of the respondents working elsewhere selected the same option. The option representing the most regular visits was "5 times per week". Among the respondents who chose this option was one student; however, there were also two responses (7%) from people who work from home and two (7%) from the ones who work from elsewhere. Another option representing a high frequency of visits was 1-2 times per week, and in this case, people who work from elsewhere visited the rooftop more than those who work from home (15% versus 12%, respectively). The hypothesis that people who work from home visit the rooftop significantly more than those who do not was not supported.

*Figure 22. Employment Location Versus How Often People Visit Rooftop Gardens*



It was hypothesized that these two groups visited the rooftops with different frequencies; one of the hypotheses was that the people who work from home used the rooftop for working. however, the data suggests that this is not true. Only eight people working from home chose to use the rooftop garden to work from there, and seven who worked elsewhere chose this option. The most popular way of use for both groups was “enjoying the view”; these 24 responses were almost all from people working from home (81%)  and 19 working from elsewhere (70%) (see Figure 20). Another finding is that more people who work from home chose the option “entertaining guests” (18 respondents, 70%) than the ones who work from elsewhere (11 respondents, 40%). The findings can be used to promote the building of features that allow entertaining guests, and providing a place for socializing.

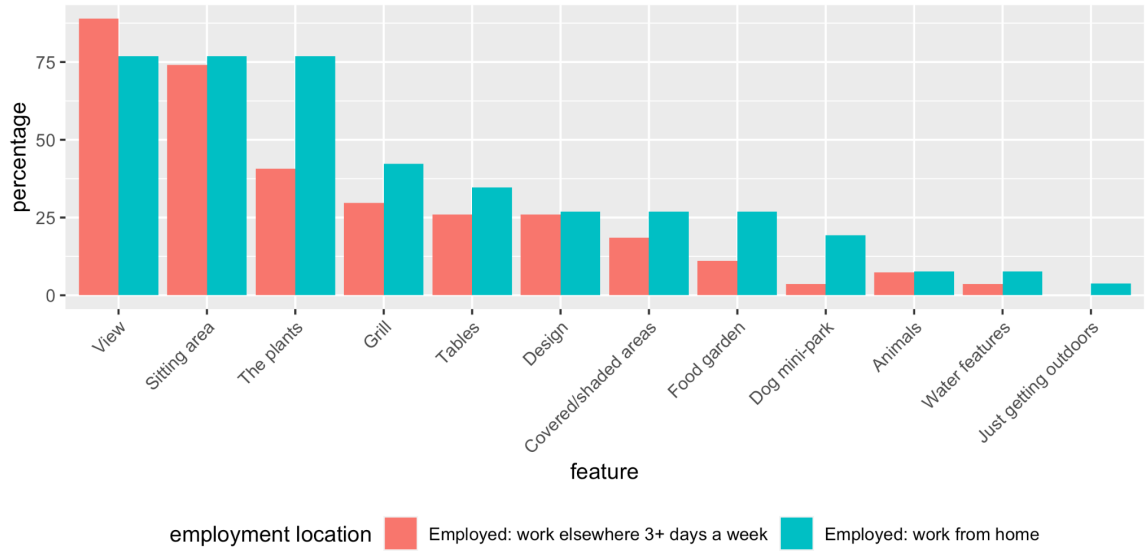
*Figure 23. Employment Location Versus How People Use Rooftop Gardens*




I also compared the two employment location groups, looking at their responses about why they feel better after visiting the rooftop gardens in the apartment buildings. Fresh air, relaxation, and mind clarity were the most popular among self-reported reasons. However, I did not find significant differences in the responses of people who work from home or elsewhere.

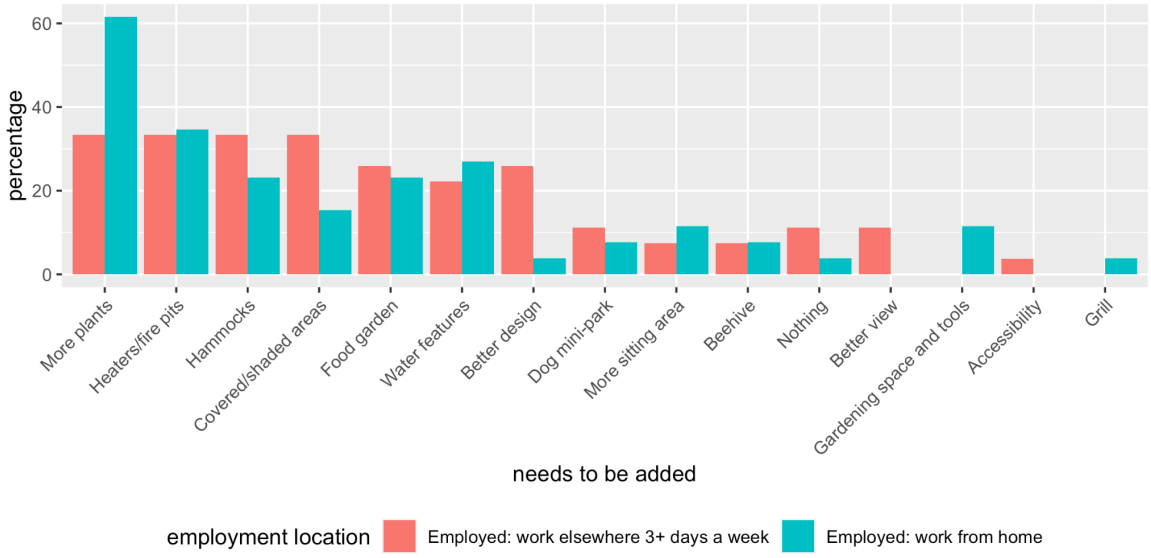
Because these groups spend different amounts of time at home (one group has the option to work from the rooftop or visit it more frequently), I hypothesized that the groups' favorite features might differ. The split bar chart has shown no significant difference between almost all rooftop features except the "plants" feature; more people who work from home like this option than the ones who work from elsewhere. In the work-from-home group, there are 77% of respondents for whom plants are a favorite feature, and just 41% of respondents in the second work-from-elsewhere group selected this option. Food garden was a favorite feature just for 11% (three) of people who work from elsewhere and for 27% (seven) of the respondents working from home (see Figure 21).

*Figure 24. Employment Location Versus Favorite Features*




Another interesting finding about plants was found in comparing the responses to the question, "What needs to be added to your rooftop?". Among the respondents working from home, 16 out of 26 (62%) think more plants should be added to their rooftop garden (see Figure 22). This finding was the only one that showed a large difference between the responses of the two groups.

*Figure 25. Employment Location Versus What Needs to Be Added to the Rooftop Garden*



# Chapter 5. Discussion

The two research questions of this study ask how the users of the rooftop gardens in Seattle's multi-family apartment buildings experience these gardens and how they benefit from them. By conducting a survey, these questions ask how people use the rooftops, what they like about them and what features they would like to see more (experience), and whether the rooftop garden visitors feel better after going to the rooftops in their apartment buildings and how (benefits, self-reported). Out of 64 respondents who took the survey, 61 answered that they used their rooftop gardens; 58 out of these 61 reported they do feel better after visiting the rooftop gardens. This amount of positive responses suggests that people do benefit from the existence of rooftop gardens in their apartment buildings. This result also supports the finding from the other studies discussed earlier in the literature review. For instance, Wilmert's work describes many benefits for the users of the rooftops and mentions that many governments encourage green roofs and offer tax incentives to promote more installations of these structures (Willmert, 2000).

Among the reasons, the respondents felt better, the most frequently selected was fresh air, which was the most popular response and made almost all the participants feel better - 52 out of 58. This is a logical finding, as the fresh air is associated with the benefit of outdoor settings and is associated with better health, mood, and nature time (Rajoo et al., 2021), which many survey takers also selected. Furthermore, relaxation and mind clarity were among the most selected options meaning that the residents can find calm and peace in their roof gardens. In addition, relaxation was the second most popular among all age categories. In addition, the competitive analyses have shown that relaxation was selected by 70% of adults and 67% of older adults, being the second most popular among both age categories, showing the importance of the features providing this opportunity once more.

The custom answers, such as “view of the mountains!”, “direct natural sunlight access not behind a window” and “the view reminds me that I live in a beautiful city.” were an addition to the finding that the opportunity to enjoy the views from the rooftop was a favorite feature for most of the respondents and the most common way of use. It was also the primary response for each age group. This finding shows that rooftop gardens can provide the views people enjoy and believe that they make them feel better. The finding shows the importance of the spaces where the residents can take in the views; the rooftops are suitable for this and, therefore, provide a valuable benefit for the dwellers.

Family time spent on a rooftop was also important for many respondents. This finding indicates the importance of the rooftop spaces as a place for socialization, confirming the results of the studies of other researchers from cities other than Seattle, that, for instance, stated that green roofs provide mental health benefits, pleasure, and social development (Kimura, Nishiwaki, & Miyata, 2008). Interestingly, in the question about the usage of the rooftops, the option “spending time with family/friends” was one of the most common; however, in the question “Why do you feel better after visiting your rooftop?”, this option was less popular. It was, however, selected more often for older adults than younger adults.

The valuable finding for future design and planning is that many people use outdoor dining amenities, such as grills, tables, and sitting areas, and many people like them the most. This result means that feature design should include these features to make the rooftop attractive. These features also were important for people from previous research (Manso et al., 2021) and provided a space for not only dining but also for spending time with others. Among custom answers are “went up for New Year’s fireworks,” “smoking,” and “harvesting garden veggies

from the amenity garden.", which shows the value of the outdoor space with a view, access to the vegetation, and fresh air, without leaving the actual building a person lives in.

Discussion of the vegetation, the third favorite rooftop feature of the respondents was "the plants." There were just ten respondents who chose gardening as a reason for visiting the space in the question, "Why do you visit your rooftop space?" which can indicate that not many rooftops have gardening opportunities or that people enjoy greenery but are not willing to maintain the garden. Moreover, some respondents selected the food garden as their favorite feature. Despite these being the most expected features of a rooftop garden, they were not top-selected. However, it is still popular, indicating that vegetation is essential for rooftop spaces. The research demonstrates that people appreciate the rooftops for the opportunities an outdoor or nature setting usually provides. For instance, the custom response for the feature question is "just getting outdoors." These results can demonstrate and reinforce the research showing a lack of green spaces overall (Van Herzele, 2003).

Furthermore, for a deeper analysis, I explored the responses of people who selected at least one of the following features answering the question, "What needs to be added to your rooftop?": food garden, gardening space and tools, and more plants. Analysis of favorite features showed an exciting finding: almost everyone, 24 of 29 respondents, also listed plants as their favorite things in the rooftop garden. Therefore, I can assume that people who select plants as their favorite feature of rooftop gardens would like to see more plants on their rooftops.

The "What needs to be added to your rooftop?" question provides insights for future planning and shows what is lacking in most rooftop gardens in Seattle. Plants became the most selected option in this question. However, after conducting a comparative analysis, I found that older adults want to see more plants than the adults group. Interestingly, in the question about favorite

features, the analysis showed that plants were a favorite feature for 66% of adults and only 50% of older adults. That could mean that the plants are a favorite existing feature of the rooftops for adults; however, a higher percentage of older adults prefer to have more of this feature on their rooftop gardens. For future designing, it can be helpful to know that people also want to see more heaters/fire pits, hammocks, water features, and shaded areas/covered areas on their rooftops.

The comparative analysis of the favorite features of people who work from home or elsewhere 3+ days a week revealed that a more significant percentage of people who work from home liked plants than those who work from elsewhere. Also, the "What needs to be added to your rooftop?" question showed that 62% of respondents working from home would like to see more rooftop plants. In comparison, only 33% of the respondents working from elsewhere selected this option answering the question. This finding indicates that people working from home appreciate plants more and want to see more of them too. The hypothesis is that people who spend more time at home because their jobs do not require any commute - lack natural features more and seek them in the buildings where they spend the most time, combining their "first place" or home and "second place," or working place, in one.

Although the most common frequency of rooftop attendance was 1-2 times per month, the second common response was "only during summer." This result is expected, as the summer weather allows us to spend more time outdoors. Furthermore, the season when the data was collected was also a limitation of the research, as people visit fewer outdoor spaces when it is cold. My research was conducted during the cold month of February. Overall, despite the limitations, the results have shown frequent attendance.

I collected demographic information from all the respondents; however, the study mainly analyzes the responses of those who selected that they visit the rooftop in their buildings and feel better after these visits. This dataset provides ample responses suitable for analysis. Some respondents selected the "prefer not to say" option in some demographic questions; however, their answers are also included and analyzed where possible.

The descriptive analysis of demographics showed that most respondents live in two Seattle neighborhoods: South Lake Union and Capitol Hill. This is not surprising as these areas are where I did most of my posting to recruit respondents, and South Lake Union was reported as a fast-developing area (Young, 2008). Still, I received answers from many other areas, even where I did not distribute the physical posters. Most of the people who took this survey are in the age range of 18-29; however, there was also a diversity of ages, and the results included a few responses from all age groups in the survey options. The most frequent race or ethnicity reported was White/Caucasian. Most respondents were employed and worked from home or elsewhere 3+ days a week. Almost all the respondents rented their apartments. This data demonstrates the average survey participant; however, it does not mean these demographics are characteristic of all rooftop visitors.

The research shows that rooftop gardens offer open green space to spend time alone and an excellent "third place" to have a barbecue dinner with friends or some fun labor time in a garden with family and cook the harvested vegetables afterward. They are a place that provides more recreation and relaxation, creates leisure opportunities, provides people with fresh produce, beautifies the cities, and provides a city view from the rooftop. These structures benefit the city residents and environment and are useful and valuable for modern sustainable cities.

# Chapter 6. Limitations and Future Directions

In conducting this study, I encountered several complications:

1. To reach the respondents during the survey promotion, the flyers with the survey QR codes were posted outside. As QR codes are not always safe (Government Technology, 2022), people could be scared of scanning them.
2. Due to the schedule of the thesis process, I could only run our survey in winter, when people go outside less than during summer or other seasons. Asking the respondents about spaces they do not visit as often during the winter might make it difficult to remember their favorite features or other details about how they use the rooftop gardens.
3. As the survey was mainly distributed via posters outside - there are more people on the streets during the summer season, and more audience can be reached.
4. This survey asks people about their familiarity and usage of building resources, so new residents are likely not included in the respondents. The survey did not ask how long people lived in a building with a rooftop garden.

Furthermore, in reporting their usage of the space, a few respondents chose certain features (food gardens, water features, and mini dog parks) that do not exist on all the rooftops. They were not included as selections on the survey. The comparative analysis showed that people who responded that their rooftops lacked natural features did not report that they used their rooftops for gardening. Therefore, this could indicate that they do not have gardens and tools for gardening. The lack of those can be the reason why they might still like this feature but cannot choose it for their favorite feature or as a way of usage, as their rooftop lacks this object. However, there were not enough responses to be conclusive. These findings can be material for future research.

The sample size of 61 respondents is enough for research. However, more responses would allow for further analysis. With more responses, it is possible to see more patterns and understand what the residents like, dislike, prefer to see more, etc. I received only three responses from people who did not feel better after visiting the rooftop. More analysis can be conducted with a bigger sample of people who feel this way as for now we cannot see any patterns that can be discussed.

As I received evidence of the multiple benefits rooftop gardens provide for cities, the planet, and people, I suggest increasing Seattle's promotion of green roofs. As many roofs may be able to be retrofitted to include extensive or, as this study examines, intensive green roofs, future researchers can conduct suitability and feasibility analyses. The literature review showed that this had been done in some cities and revealed multiple possibilities for rooftop retrofitting on structures that allow it (Giannopoulou et al., 2019).

Moreover, as multi-family buildings' rooftops are mostly inaccessible to non-residents, and there could be more green rooftops and rooftop parks and gardens on these buildings, the issue of public accessibility can become a relevant topic for future research.

Another limitation is that I mostly received responses from people from the age range of 18-29. While I received a variety of responses, because most of the data was from younger survey participants, I was unable to explore the experiences of older people. This is likely because of different housing preferences across age ranges, while my survey only covered inner-city multi-family housing (Joint Center for Housing Studies of Harvard, 2018).

# Chapter 7. Applications and Recommendations

Current Seattle regulations, such as the Green Factor discussed in the literature review, state that many types of green features can increase the green score of a building. However, there are specific regulatory requirements for green roofs in Seattle and many other cities throughout the US. As the literature review showed, rooftop gardens have many positive environmental and social impacts on city dwellers, and this research suggests that people enjoy them for many reasons. Therefore, I recommend that the City of Seattle consider additional incentives for rooftop gardens to promote them more actively. Louise Lundberg, a specialist on green roofs from the Scandinavian Green Roof Institute in Sweden, noticed that many roofs in downtown Seattle could become green roofs (Kohli, 2005).

My research results recommend checking the suitability of the existing roofs for intensive types to include amenities into the design and promote retrofitting of the wasted spaces. All future buildings with flat roofs should be designed in a way that they could be covered with greenery. As the survey showed, people enjoyed plants, views, and grills, but rooftops need not be fully accessible. Even using a portion of the roof represents a significant opportunity for people's well-being and the environment.

There is value for people in accessing and using rooftop gardens. Therefore, rooftop green spaces should become more accessible to the public, covering not only residential buildings that have limited access but also publicly accessible buildings. One of the ideas is to target for conversion underutilized rooftops of parking areas, convention centers, and offices.

Using the survey answers about favorite features, ways of usage, self-reported reasons for better well-being, and features that people would like to see added on their rooftops, I identify the most important things for residents. As mentioned in the Limitations and Future Research

chapter, I recommend a more detailed survey that would include more responses to explore what additional benefits people might see and how they experience these spaces. However, based on this research, I can conclude that people mostly appreciate the opportunity to enjoy the rooftop views, the existence of plants, nature time, and fresh air access. Considering the problem of rapid urbanization (United States Environmental Protection Agency, 2023), lack of nature, and parks in the cities (Louv, 2005) discussed in the literature review, this indicates that people use the building they live in to enjoy the views and the existence of plants - the features mainly provided by the natural environments. Therefore, the findings reveal that rooftop gardens are useful for people when there is a lack of easily accessible natural areas in the cities.

On-ground parks often provide a row of other possibilities, such as relaxation, recreation, sunbathing, outdoor cooking and dining, and working as places for spending time with friends and family. These were also the options that people had chosen many times, showing that these park features provided by the rooftop gardens in their apartment buildings are important for them, and the dwellers benefit from having these opportunities right in their houses. Therefore, I recommend designing future rooftop gardens with these findings in mind as they show that people appreciate the rooftop spaces for having the aforementioned listed features of the on-ground parks.

The findings also demonstrated that different age categories appreciate features differently. For example, the study indicates that more older adults prefer amenities for spending time with family and friends. Therefore, more features for this purpose can be built on the rooftops of the buildings focusing on providing housing for older adults. The features can include more sitting, tables, family games, etc. Although, less but still many younger adults also enjoy spending time with their family, friends, and guests in their rooftop gardens. Therefore, for the dwellers' benefit,

increasing the number of features suitable for having quality time with other people is generally recommended.

Furthermore, the survey showed the importance of plants for everybody but demonstrated that older people would like to have more of them. This information is also an important finding that can be useful for planning and designing buildings with rooftop gardens.

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## APPENDIX A: SURVEY QUESTIONS

Hello!

My name is Yuliia, I am a graduate student at the University of Washington, working on my thesis about rooftop gardens in Seattle. This survey is my way of analyzing the social benefits of these spaces and what people think of them. Please, participate in this completely anonymous survey that will take just 3 minutes of your time to tremendously help my research!

Must be 18+ to take the survey!

The survey is completely anonymous, no need to log in!

If you have any questions or concerns, please contact my committee chair Branden Born

bborn@uw.edu

TAKE THIS SURVEY if the rooftop in your apartment building looks like this:

(with an edible or a regular garden and amenities)

But not like this:

(no amenities, just a green lawn)

**1. Do you visit the rooftop space in your apartment building?**

yes/no

*Section if the answer was "no"*

**2. What are your reasons for not visiting the rooftop?**

Don't garden

Don't have time

Don't like the design

It is too small

Prefer regular on-ground parks

Cannot access it

Other (please specify)

**3.Is it still of value to you, and in what way? - specify in "other"**

yes/no/other

*Section if the answer was "yes"*

**4. How do you use it? (multiple answers possible)**

Work to maintain the space

Do my work there (for example, bringing a computer, writing, knitting, etc)

Exercising

Dog walking

Playing games

Sunbathing

Enjoying the views

Gardening

Outdoor grilling/cooking

Entertaining guests

Spending time with friends and family

Recreational use other than gardening (reading, drawing, thinking)

Other (please specify)

**5.. How often do you visit your rooftop?**

5+ times per week

1-2 times per week

1-2 times per month

Once in several months

Been there just once or twice

Only during summer - regularly

Only during summer - once or twice per season

I maintain the garden there and my attendance depends on it

**Do you feel better after visiting the rooftop?**

yes/no/other (please specify)____

**7. If yes, how or why? (multiple answers possible)**

Fresh air

Fresh produce access

Mind clarity

Nature time

Exercise

Spending time with friends/family

Relaxation (sunbathing, meditating, etc)

Recreation (playing games, hobby, etc)

I do not benefit from the rooftop

Other (please specify)

**8. What are your favorite features? (multiple answers possible)**

Food garden

The plants

Animals

Water features

Grill

Sitting area

Tables

Design

View

Dog mini-park

Covered/shaded areas

Other (please specify):

**8. What needs to be added to your rooftop? (multiple answers possible)**

Food garden

Gardening space and tools

More plants

Beehive

Dog mini-park

Grill

More sitting area

Hammocks

Tables

Hitters/firepits

Covered/shaded areas

Water features

Accessibility

Better design

Better view

Other (please specify)

*Demographics*

**10. What is your age?**

18-29

30-39

40-49

49-65

65+

Prefer not to say

**11. Which race or ethnicity best describes you?**

American Indian or Alaska Native

Black or African American

Native Hawaiian or Other Pacific Islander

Hispanic / Latinx

Asian

White / Caucasian

Race and Ethnicity are unknown

Multiple ethnicities

Other (please specify)

Prefer not to say

**12. Do you rent or own your apartment?**

Rent/Own/Prefer not to say

**13. What is your employment status?**

Student

Employed: work from home

Employed: work elsewhere 3+ days a week

Unemployed

Retired

Prefer not to say

Other (please specify)

**14. The neighborhood you live in:**

Ballard/Beacon Hill/ Belltown/Capitol Hill/Central District/Chinatown-International District/Columbia City & Rainier Beach/Downtown Seattle/First Hill/Fremont and Wallingford/Northgate/Pioneer Square/Queen Anne/SoDo & Georgetown/South Lake Union/ University District/ Wallingford, Green Lake & Phinney Ridge/Waterfront/ West Seattle/White Center/Other/Prefer not to say

THANK YOU FOR YOUR ANSWERS AND TIME!