

THE ANALYSIS OF GREENHOUSE GAS EMISSIONS CAUSED BY
INDIVIDUALS IN TURKIYE FROM A TIME-USE PERSPECTIVE

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ABSTRACT

THE ANALYSIS OF GREENHOUSE GAS EMISSIONS CAUSED BY INDIVIDUALS IN TURKIYE FROM A TIME-USE PERSPECTIVE

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The Paris Agreement aims to limit the global average temperature increase to below 2 degrees Celsius compared to the long-term average. Türkiye ratified the Paris Agreement in 2021 to combat and adapt to climate change and pledged to achieve net-zero emissions by 2053. Since then, the decision and implementation of climate policies have gained momentum in Türkiye.

In Türkiye, households account for 59% of the total emissions caused by end-consumers. Also, the time-use habits of individuals are important determinants of consumption preferences. Therefore, this study analyses the environmental impact of individuals' daily time-use preferences in Türkiye. For this purpose, we harmonise the environmentally extended input-output table EXIOBASE and the TURKSTAT Time-Use Survey with the assistance of the TURKSTAT Household Budget Surveys.

Subsequently, we calculate the hourly greenhouse gas emissions of individuals' time-use activities. In the following step, we describe the time-use habits of individuals and the associated carbon footprints by demographic groups.

This study is the first to analyse carbon footprints from a time-use perspective in a developing economy, Türkiye. The study, first, identifies the activity categories that exhibit high GHG emission intensity, highlighting the need to reduce the GHG content of the products used in such activities. Second, the results point out several possibilities for reducing GHG emissions by changing the time-use compositions of different demographic groups. By localising policy recommendations and identifying the needs of various demographic groups, this study offers a roadmap for policymakers to enable individuals to adopt environmentally friendly habits and reduce their carbon footprints.

Keywords: Greenhouse Gas Emissions, Time-use Analysis, Climate Change, Household Behaviour, Eco-friendly Lifestyle

ÖZ

TÜRKİYE’DEKİ BİREYLERİN NEDEN OLDUĞU SERA GAZI EMİSYONLARININ ZAMAN KULLANIMI PERSPEKTİFİNDEN ANALİZİ

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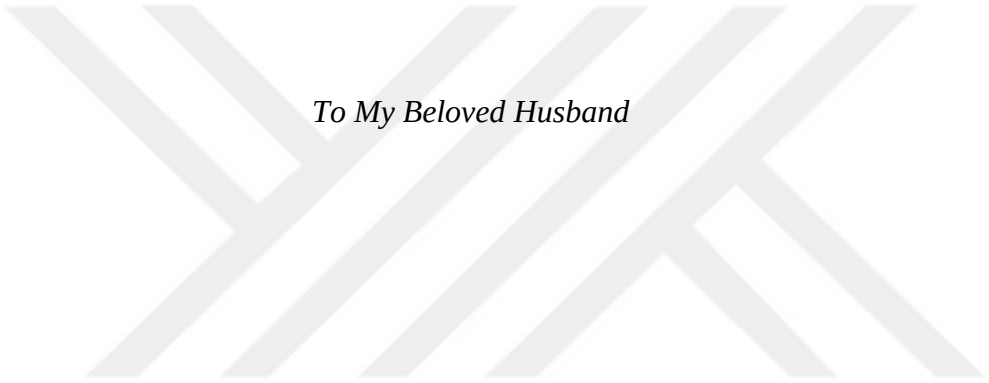
Paris Anlaşması, küresel ortalama sıcaklık artışını uzun vadeli ortalamaya kıyasla 2 santigrat derecenin altında sınırlamayı amaçlamaktadır. Türkiye, iklim değişikliğiyle mücadele ve uyum için 2021 yılında Paris Anlaşmasını onaylamış ve 2053 yılına kadar net sıfır emisyona ulaşma taahhüdünde bulunmuştur. O tarihten bu yana Türkiye’de iklim politikalarının kararlaştırılması ve uygulanması ivme kazanmıştır.

Türkiye’de hanelerin neden olduğu sera gazı emisyonları son tüketicilerin neden olduğu toplam emisyonların %59’unu oluşturmaktadır. Ayrıca, bireylerin zaman kullanım alışkanlıkları, tüketim tercihlerinin önemli bir belirleyicisidir. Bu nedenle, bu çalışma Türkiye’de bireylerin günlük zaman kullanım tercihlerinin çevresel etkilerini analiz etmektedir. Bu amaçla, çevresel olarak genişletilmiş girdi-çıktı tablosu EXIOBASE ve TÜİK Zaman Kullanım Anketini, TÜİK Hanehalkı Bütçe

Anketleri yardımıyla harmonize ettik. Ardından, bireylerin zaman kullanım faaliyetlerinin saatlik sera gazı emisyon yoğunluklarını hesapladık. Sonraki adımda, bireylerin zaman kullanım alışkanlıklarını ve buna bağlı sera gazı emisyonlarını demografik gruplara göre tanımladık.

Bu çalışma, gelişmekte olan bir ekonomi olan Türkiye'de sera gazı emisyonlarını zaman kullanımı perspektifinden analiz eden ilk çalışmadır. Çalışmada yüksek sera gazı emisyon yoğunluğu sergileyen faaliyet kategorileri belirlenerek bu tür faaliyetlerde kullanılan ürünlerin sera gazı içeriğini azaltma ihtiyacı vurgulanmaktadır. Ulaşılan sonuçlar, farklı demografik grupların zaman kullanım bileşimlerini değiştirerek sera gazı emisyonlarını azaltmak için çeşitli olasılıklara işaret etmektedir. Bu çalışma, politika önerilerini yerelleştirerek ve çeşitli demografik grupların ihtiyaçlarını belirleyerek, bireylerin çevre dostu alışkanlıklar edinmelerini ve karbon ayak izlerini azaltmalarını sağlamak için politika yapıcılara bir yol haritası sunmaktadır.

Anahtar Kelimeler: Sera Gazı Emisyonu, Zaman Kullanım Analizi, İklim Değişikliği, Hanehalkı Davranışları, Çevre Dostu Yaşam Biçimi



To My Beloved Husband

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LIST OF ABBREVIATIONS

CBAM: Carbon Border Adjustment Mechanism

CO₂e: Carbon dioxide equivalent

EE-MRIO: Environmentally Extended Multi-Regional Input-Output Table

ETS: Emission Trading System

EU: European Union

EUA: European Union Allowances

EUROSTAT: The Statistical Office of the European Union

ETS: Emission Trading System

GHG: Greenhouse Gas

HBS: Household Budget Survey

Kg: kilogram

Mt: million tonnes

TURKSTAT: Turkish Statistical Institute

CHAPTER I

INTRODUCTION

The Paris Agreement, was signed by 193 countries at the 2015 United Nations Climate Change Conference and enforced in 2016, aims to limit the global average temperature increase to below 2 degrees compared to the long-term average. Within this framework, it is envisaged that the participating countries will reduce greenhouse gas emissions, promote sustainable development, develop clean energy technologies and adapt to the adverse effects of climate change.

Türkiye signed the Paris Agreement in 2016 as part of its efforts to combat and adapt to climate change. In 2021, with the passage of the Paris Agreement by the parliament and the publication of the Green Deal Action Plan prepared within the framework of harmonisation with the European Green Deal, implementation of climate change policies have accelerated.

In the international literature, carbon tax and emission trading systems have come to the fore as efficient and effective methods among policies to reduce carbon footprint. Although various studies have demonstrated the success of these methods (Andersson, 2019; Colmer et al., 2020), it is evident that there is still a long way to go to prevent global warming (United Nations, 2023). Microeconomic studies have recently gained momentum in the international literature to develop more creative policies and evaluate the socioeconomic impacts of the policies developed. These studies aim to measure the heterogeneous contributions of firms and households to the carbon footprint. This approach can help determine more accurate micro-based policies and

analyse the effects of existing and planned policies on various social groups (income, education, age, etc.).

According to calculations for 2015 using the EXIOBASE database, households are responsible for 322 million tonnes, or 59 per cent, of the total 549 million tonnes of CO_{2e} demand-driven emissions in Türkiye. The term demand-driven emissions is used to describe the greenhouse gas (GHG) emissions that are generated as a consequence of the consumption of goods and services by end-users, such as households. Therefore, households are also a factor to be considered in carbon footprint reduction activities. Two main methods stand out in micro studies on households in environmental economics. The first one is the calculation of the carbon footprint corresponding to household expenditures through household budget surveys (Wang et al., 2016; Ivanova and Wood, 2020; Theine et al., 2022; Sri et al., 2023).

The second method is to associate individuals' consumption behaviour with their time-use and thus calculate the carbon footprint of activities performed during the day (e.g., Druckman et al., 2012; Smetschka et al., 2019; Yu et al., 2019; Jiang et al., 2023). While most demand-side studies examine the relationship between how households spend their money and the GHG emissions caused by these expenditures, the impact of individuals' time-use habits on GHG emissions has been secondary (Druckman et al., 2012).

Individuals' consumption behaviour is strongly influenced by their time-use habits as well as their income. For example, an individual may spend his/her free time reading a book or walking in the park, while another may prefer to socialise in a restaurant. Their expenditures and carbon footprints will be different because of this choice. Also, while income varies for everyone, we all have the same 24 hours a day. Time-use analysis enables a shift from the perspective of consuming less to reduce carbon footprint to having less carbon footprint by spending time on more sustainable, low-carbon, and enjoyable activities (Smetschka et al., 2019).

In order to provide demand-side recommendations for carbon footprint reduction activities and to understand the environmental impacts of various lifestyles, this study

analyses the time use habits of individuals in Türkiye and calculates the amount of emissions and carbon intensities caused by daily activities. To the best of our knowledge, this is the first study in Türkiye and developing economies except China. This is important to understand whether the findings in the developed world carry over to middle-income, developing economies.

In the current study, we adapt the environmentally extended input-output table (EXIOBASE) and the TURKSTAT Time Use Survey to use them together with the Household Budget Survey (HBS) and various concordance matrices. Based on this, we estimate the GHG emission intensities of time-use activities. We also analyse the time-use tendencies of individuals according to various demographic characteristics such as gender, employment status, marital status, and age, as well as the environmental impacts of these tendencies.

The study's main findings are that eating and drinking activity is relatively more GHG-intensive and that the traditional gender roles shape the time-use patterns of men and women, hence their carbon footprints. Women spend a disproportionate amount of time on unpaid domestic labour, resulting in high emissions and limited time for lower GHG-intensive activities. In addition to gender, we observe significant differences between working and non-working people regarding time-use habits and, thus, daily emissions. For workers, high working hours and mobility time lead to a time squeeze, pushing individuals towards more GHG-intensive activities. On the other hand, unemployed men, with excess free time and minimal domestic responsibilities, contribute to higher emissions through free activities and time travelled for free time activities. Another finding is that the average GHG emission intensity per hour in Türkiye is much lower than in developed countries compared to the results of studies in the literature.

Based on these results, we have four main policy recommendations. The first one concerns reducing the GHG emission intensity of the eating and drinking category. The others target the working group (especially working men), women (especially non-working and married women), and non-workers (especially non-working men).

Policy implications will be explicitly discussed in the Main Lessons and Policy Implications chapter.



CHAPTER 2

BACKGROUND AND LITERATURE REVIEW

2.1. Background

Signed by 193 countries at the 2015 United Nations Climate Change Conference with the participation of 196 countries and recognised as an essential milestone in the fight against global climate change, the Paris Agreement entered into force in 2016. The Paris Agreement, whose main objective is to keep the increase in global average temperature below 2 degrees Celsius compared to the long-term average, requires participating countries to reduce greenhouse gas emissions, promote sustainable development, develop clean energy technologies and adapt to the adverse effects of climate change. In December 2019, the European Union published the European Green Deal to become the first climate-neutral continent by 2050.

Türkiye signed the Paris Agreement in 2016 as part of efforts to combat and adapt to climate change, which is of great importance for the future of our world. In 2021, the Turkish Parliament ratified the Paris Agreement. Also, the Green Action Plan was published in the same year. The Action Plan, prepared within the framework of harmonisation with the European Green Deal, includes a total of 31 targets and 81 actions under nine main headings in line with the objectives of sustainable growth, transition to a green economy and limiting the increase in emissions (Republic of Türkiye Ministry of Trade, 2021). Targets concerning the Carbon Border Adjustment Mechanism and carbon pricing mechanisms seems to be the most prominent ones among others in the Action Plan. Carbon tax and emission trading systems are

examples of the main carbon pricing mechanisms that stand out as effective tools in reducing carbon footprints in the literature.

The EU Emissions Trading System (ETS) aims to keep emissions at the upper limit by giving companies the right to emit greenhouse gases within the limits of EU Allowances (EUAs). EUAs, each equivalent to one tonne of CO₂ emissions, can be issued free of charge or auctioned by the EU Member States to companies subject to the ETS. Furthermore, companies can trade their allowances on the secondary market. Thus, the price of allowances is determined under market conditions. If the price of allowances is above the cost of emission reduction, the company will reduce emissions. If it is below, it will purchase allowances (Republic of Türkiye Ministry of Trade, 2023). However, there is a risk of market manipulation and speculation in the ETS. In addition, if emission permits are provided in excessive amounts or at a low cost, this may reduce the incentives to reduce emissions. ETS can also be complex and administratively burdensome, which can be a barrier, especially for small and medium-sized enterprises.

Another carbon pricing instrument, the carbon tax, works on the principle that products are taxed according to the amount of direct and indirect emissions they cause. By raising the price of emission-intensive products, it is aimed to encourage consumers and producers to switch to products with lower carbon emissions. Although its effectiveness in reducing carbon footprint has been shown in various studies (Andersson, 2019), it has been revealed that carbon tax may be regressive for low-income countries, and low-income households will be disproportionately affected by the tax (Feindt et al., 2021). Thus, levying a carbon tax may cause distortions on distribution of income and/or allocation of resources.

In order to prevent products imported from countries that do not impose carbon pricing and thus have lower costs from gaining a competitive advantage in the market, the Carbon Border Adjustment Mechanism (CBAM) has been proposed by the EU. Organised in parallel to the EU ETS, the CBAM imposes additional taxes on imported products in order to prevent global carbon leakage and to encourage other countries to cleaner production. This regulation may cause developing countries, which are more

dependent on carbon-intensive production methods, to lose competitiveness in trade, to reduce output in energy-intensive sectors, consequently, negatively affecting their economic development and social welfare (Gu et al., 2023). In addition, it is also criticised that border carbon adjustments may create a protectionist effect on global trade and lead to international trade disputes (Holmes et al., 2011).

Although the production-oriented policies implemented so far to combat climate change offer important opportunities for reducing greenhouse gas emissions, they also include some of the above-mentioned dangers for developing countries. It is important to adapt these policies so as not to disrupt economic development and welfare. On the other hand, more than focusing on the production process may be required to achieve the targeted carbon footprint reduction goals.

In this context, the importance of consumption-oriented studies supported by microeconomic data is increasing in the environmental economics literature. These studies emphasise that consumers' preferences and behaviours play a critical role in the process from the production to the consumption of products and pave the way for individuals and households to understand their carbon footprints and to propose precise policies to reduce them.

2.2.Literature Review

In the field of environmental economics, research efforts have recently intensified to elucidate the heterogeneous impact of environmental policies on distinct societal segments through the utilisation of microeconomic data. This endeavour is undertaken to identify vulnerable groups and contribute to the formulation of environmental policies at the micro-level. In the literature, two main methods stand out in analysing the relationship between consumer habits and carbon footprint. The first and more common one is the calculation of GHG emissions corresponding to household consumption expenditure through household budget surveys. The second method is to associate individuals' consumption behaviour with their time-use and thus calculate the GHG emission intensity of activities performed during the day.

2.2.1. Expenditure Approach

Druckman and Jackson (2009) examined the carbon footprint of UK households between 1990 and 2004 using the Family Expenditure Survey (ONS) and a quasi-multi-regional input-output (QMRIO) model. The study found that CO₂ emissions attributable to households increased by 15 per cent by 2004, with a significant proportion of emissions originating outside the UK. It also reveals wide variation in carbon footprints between different segments of the UK population and that recreation and leisure activities account for a significant share of household emissions. The findings emphasise the importance of considering infrastructure and lifestyle targets when addressing household CO₂ emissions and suggest targeted policies towards segments with higher carbon footprints.

Ivanova and Wood (2020) examined the carbon footprints of households in the EU using household budget surveys and environmentally extended multi-regional input-output table EXIOBASE. They found that the emissions of the top 10 per cent of income are significantly higher than the bottom 50 per cent. Mi et al. (2019) analysed cross-city carbon emissions in Hebei, China, and showed that imports have a significant share in consumption-based emissions. Theine et al. (2022) investigated the impact of income and consumption expenditures on the carbon footprint in Austria. They found that the emissions of the top 10 per cent of income were 4.1 times higher than the bottom 10 per cent. Wang et al. (2016), while examining the effects on CO₂ emissions across income groups in China, found that the increase in income increases per capita emissions. Finally, Girod and de Haan (2009) examine how consumption patterns in Switzerland affect GHG emissions, emphasising the importance of low GHG emission consumption patterns. These studies show that household consumption patterns significantly impact carbon footprints and that the transition to sustainable consumption patterns can play a critical role in combating climate change.

2.2.2. Time-use Approach

Schipper et al.'s 1989 study is considered one of the pioneering studies on the relationship between time-use and energy consumption. This study comprehensively

analyses the effects of individuals' lifestyles and consumer activities on energy use in the United States. The study considers the location, duration and form of activity as determinants of consumer behaviour through household time-use and consumption expenditure and considers energy demand as an interaction of these factors beyond price and income alone. The study's main objective is to reveal how behavioural changes have shaped energy use from the past to the present and highlight that the likely evolution of individual and societal activities is critical for understanding future energy demand. In particular, travel-related activities are found to be more energy intensive than activities that take place at home or in service buildings, and it is concluded that the future degree of mobility of society will be a determinant of energy demand. These findings highlight the importance of focussing on changes in the activity patterns of individuals and societies in order to understand the future dynamics of energy demand.

In the later years, studies analysing time-use and energy use for different countries have diversified. Examples of such studies are Finland (Jalas, 2002; Jalas, 2005; Jalas and Juntunen, 2015), Canada (Brenčić and Young, 2009), Norway (Aall, 2011) and France (De Lauretis et al., 2017). These studies, which provide a deeper understanding of time-use and energy consumption, have pioneered other relatively less practised subjects examining the relationship between time use and GHG emissions. Four studies in the literature systematically estimate emissions based on time use activities: UK (Druckman et al., 2012), Austria (Smetschka et al., 2019), China (Yu et al., 2019), and Japan (Jiang et al., 2021).

Druckman et al. (2012) calculated GHG emissions per unit time of time-use activities by combining the UK Environmental Accounts (2008 UK Environmental Accounts), the environmentally extended input-output table (EEIO-SELMA) and the time use survey (2006) with various concordance tables. Excluding paid and voluntary working hours, formal training periods and holidays, the study focused only on non-work activities and their environmental emissions; 86% of daily time was analysed in 18 different time use categories. The findings highlight gender differences in carbon footprints and reveal that women have higher emission values compared to men

because they spend less time on leisure activities that require lower GHG emission and more time on housework.

Smetschka et al. (2019) calculated the GHG emissions intensities of Austrian household daily activities using the Austrian time use survey (2008-2009), household budget survey (2010) and a multi-regional input-output model (EORA-MRIO). The 427 time-use activities were reduced to 83, of which 63 were allocated to mobility activities and the remaining 20 to 4 functional time-use activities: personal time (sleeping, personal care, eating and drinking, etc.), committed time (cleaning, caring for others, meal preparation, repair, etc.), contracted time (work and formal education) and free time (entertainment and culture, watching TV, voluntary activities, etc.). Each category of expenditure (COICOP) was allocated to one or more time-use activities to obtain a time-consumption concordance matrix, thus estimating each activity's average GHG emission intensity per hour. The study's main findings were that personal time is relatively less GHG-intensive and that the traditional gender division of labour shapes the time use patterns of men and women and, thus, their carbon footprints. In addition, household size, income, location, and infrastructure accessibility are among the factors that affect carbon footprint.

Yu et al. (2019), in their study, used Chinese time use survey (2008), household consumption data (2009), household direct energy consumption data (2009) and tried to transform the energy and emission problem into a finite time-use problem by using input-output analysis method. Unlike other studies, the analysis is extended to six developed countries (Japan, Austria, Germany, Finland, Finland, the United Kingdom and the United States) using similar data sets for the relevant countries. The GHG emissions intensities of 14 time-use activities were calculated. The activities were classified as long-term and low GHG-intensive (sleep and rest, recreation and leisure, eating and drinking, travelling, etc.), short-term and high-GHG intensive (repairs, gardening and pet care, etc.), short-term and low-GHG intensive (entertainment and culture, sports and outdoor activities, etc.), long-term and high-GHG intensive (food preparation and dishwashing, personal care, etc.). In the study, regional and international differences were examined. For example, it was observed that the GHG intensity of travelling activity was higher in the USA and lower in Japan. This indicates

that to make correct inferences and practical policy recommendations in carbon footprint reduction studies, each country should be evaluated individually, and similar studies for different countries should be increased. In this context, our study will be an important source that will be comparable to the international literature in the context of a developing country, Türkiye.

The most recent study approaching carbon footprint reduction studies from the perspective of time use and the most comprehensive study in terms of the number of daily activities (85 categories) was conducted by Jiang et al. (2022) for Japan. Similar to previous studies, the household budget survey (NSFIE, 2004), the time use and leisure activities survey (STULA, 2006) and an environmentally extended input-output table were used. In the first step of the two-step analysis, direct and indirect emissions of consumption products were calculated using the household budget survey and input-output table. In the second step, consumption products are matched with time-use activities, the emissions of consumption products calculated in the first step are allocated to activities, and the emission intensity of activities is calculated.

The UK-focused study by Druckman et al. (2012) took a significant step forward in calculating the GHG emissions of time-use activities, while Smetschka et al. (2019), Yu et al. (2019) and Jiang et al. (2021) applied similar methodologies in Austria, China and Japan, revealing the situations in different countries. Each study analyses the effects of various factors on carbon footprint, ranging from gender differences to household size and income level, while also providing potential strategies for energy consumption and emission reductions. These comprehensive analyses are critical for developing specific policy recommendations to guide efforts to reduce the carbon footprint, considering each country's unique situation.

In line with the development mentioned above in the international literature, this study will examine the environmental impact of individuals' daily time use preferences in Türkiye. Hourly carbon footprints of time use activities of individuals will be calculated through harmonisation of the environmentally extended input-output table EXIOBASE with TURKSTAT Time Use Surveys with the help of TURKSTAT Household Budget Survey and various concordance tables. Then, the time-use habits

of individuals, according to their demographic groups (gender, employment status, marital status, and age), will be analysed. This Türkiye-specific study will be the first of its kind in developing economies and will enable the design of suitable and feasible policy recommendations for these economies. This approach will add a new dimension to efforts to reduce the carbon footprint with detailed policy recommendations that support sustainable living practices from the perspective of time use and are prepared by considering local conditions and demographic structures.



CHAPTER 3

METHODOLOGY

3.1. Data Sets

3.1.1. EXIOBASE3

EXIOBASE (Stadler et al., 2021) is an Environmentally Extended Multi-Regional Input-Output database (EE-MRIO). This open-source database contains various metrics that measure the environmental impact, i.e. direct and indirect emissions, from 200 different products. The emission coefficients represent the kgCO₂ equivalent of CO₂, CH₄, N₂O and SF₆ emitted by spending one million Euros on any product. The mix of the various emission factors are decided using the Global Warming Potential 100 (GWP100) metric (Solomon et al., 2007). Emission coefficients vary between countries and years due to differences in transport costs, input-output relationships and production methods. EXIOBASE3 has data for the years 1995-2022 for 44 countries and five remaining regions of the world. We effectively use the total expenditure data and emission coefficients of these 200 products reported in EXIOBASE v3.8.2. The process of obtaining emission coefficients using the EE-MRIO approach is beyond the scope of this study. Peters and Hertwich (2004) and Stadler (2021) can be consulted for further reading on the subject.

EXIOBASE3 also includes supply-use tables (SUT) based on information from national accounts. SUTs contain information on annual expenditures at the country level at basic prices (consumer price minus taxes and trade & logistics margins) for 200 products, as well as information on trade, transport and tax margins for these

products. This information helps convert survey expenditures presented at purchaser prices into basic prices and correct under- or over-reporting.

The table below gives the total indirect and direct emission values of end consumers (households, government, firms and non-profit organisations) in Türkiye for 2015, calculated over 200 EXIOBASE products.

Table 3.1. Consumption-based Emissions according to EXIOBASE (in million-tonnes CO₂ equivalent)

	Total Indirect Emissions	Total Direct Emissions	Total Emissions
Final consumption expenditure by households	282.37	39.80	322.17
Final consumption expenditure by non-profit organizations serving households (NPISH)	18.03	1.24	19.27
Final consumption expenditure by government	57.29	5.19	62.48
Gross fixed capital formation	106.36	0.00	106.36
Changes in inventories	38.37	0.00	38.37
Changes in valuables	0.00	0.00	0.00
Total	502.43	46.23	548.65

According to TURKSTAT data, 2015 total greenhouse gas emissions are 475 mt of CO₂e. While this value is calculated based on production data, EXIOBASE calculates consumption-based emissions. Therefore, the 548 mt of CO₂e emissions attributed to Türkiye include the emissions of imported goods. In 2015, Türkiye posted a current account deficit of USD 32.1 billion and a foreign trade deficit of USD 6 billion 183 million (CBRT, n.d.; TURKSTAT, 2016). The negative emissions from the current account deficit (exports minus imports) will reduce the 548 mt of CO₂e emissions calculated from EXIOBASE data and bring us closer to 475 mt of CO₂e emissions. Thus, we confirm that EXIOBASE emission data are consistent with real data, and no additional scaling process is required.

According to EXIOBASE calculations, households are responsible for 59 per cent of total demand-side emissions in Türkiye, 2015:

Table 3.2. Shares of Demand-side Emissions, 2015 (in million tonnes)

	Emissions	Share
Households	322	59%
Companies	145	26%
Government	63	11%
Other	19	3%
Total	549	100%

Note: Author's calculations based on EXIOBASE

Therefore, it is important to focus on individuals and their choices to reduce GHG emissions and achieve net-zero by 2053.

3.1.2. Household Budget Survey

The Household Budget Survey conducted by TURKSTAT is a comprehensive dataset that provides information on households' socio-economic status and consumption habits. Although the most recent version was published in 2022, we use the 2015 HBS since the time use survey is from 2014-2015. Between 1 January and 31 December 2015, 15,264 sample households were surveyed every month for one year, and the number of valid households are 11,491.

The Classification of Individual Consumption According to Purpose - COICOP (V.2011), a national classification system with five digits, is used to classify consumption products. The dataset provides expenditures on 303 COICOP products; it also includes demographic information on households and individuals¹.

¹ Drugs (narcotics), games of chance, and prostitution categories are excluded in this study.

We mainly use the HBS as an aid to transform the COICOP-EXIOBASE (67x200) concordance table of Ivanova and Wood (2020) into the EXIOBASE-COICOP (200x67) table. The details of this process are discussed in *section 3.2*.

3.1.3. Time-Use Survey 2014/2015

Within the framework of time use surveys initiated by EUROSTAT and aiming to obtain internationally comparable data, TURKSTAT conducted the first Time Use Survey between 1 January and 31 December 2006. We use the latest survey in this study conducted from 1 August 2014 to 31 July 2015. In this survey for the 2014-2015 period, a total of 11,440 sample households were surveyed. Individuals aged ten years and above were asked to record their daily activities in 10-minute intervals on two separate days, a working day and a weekend day.

The microdata set includes the respondents' characteristics, such as gender, age, education, and employment status, as well as factors such as household income level and housing characteristics.

Daily activities are classified according to the HETUS Activity Coding List proposed by EUROSTAT, and a total of 108 different time-use activities were grouped under ten main categories. The main categories are respectively as follows: Personal care (0), employment (1), education (2), household and family care (3), voluntary work and meetings (4), social life and recreation, sports and extreme sports (6), hobbies and games (7), mass media (8) and travelling and unspecified time use (9).

In this study, we reorganise and examine the grouping under 21 time-use activities, similar to the article by Smetschka et al. (2019). In *Appendix A*, it is explained how the 108 activities presented to the TURKSTAT time-use survey were reorganised under 21 categories.

We analyse the 21 time-use activities under the functional time-use framework, as in Smetschka et al. (2019). The 21 time-use activities and the functional-time use categories they belong to are as follows:

Table 3.3. Functional Time-use Categories

Functional Time-use Categories	21 Time-use Activities
<i>Personal Time</i>	Sleep and rest Personal Care Eating & Drinking
<i>Committed Time</i>	Repairs & Gardening Food Preparation & Dish Washing Caring for others Cleaning, tidying Shopping, Civic Matters & Services
<i>Contracted Time</i>	Work Study
<i>Free Time</i>	Entertainment & Culture Pet care Sport & Outdoor Activities Spending time with family/friends Reading Recreational courses & study Hobbies & Games Watching TV & Videos/DVDs, Listening to Radio & Music Eating out Volunteering
<i>Mobility Time</i>	Mobility

Functional time-use analysis suggests that time is the primary source of the social system, with individuals engaging in the production and reproduction of activities under four functional subsystems: the person system (personal time, for basic biological needs), the household system (committed time, unpaid domestic labour), the economic system (contracted time, work and study), and the community system (free time and socialisation). Although mobility time is not a functional time-use category in itself, it does link other activities (Ringhofer and Fischer-Kowalski, 2016).

3.2. Harmonization of Data Sets

We need two different concordance matrices to calculate emissions, detailed in the section 3.3, and to attribute the calculated emissions to time use activities: EXIOBASE product classifications to COICOP consumption expenditure classifications (200x67) and COICOP consumption expenditure classifications to time use activities (67x21).

There is no universally accepted method in the literature for matching EXIOBASE products to COICOP products, nor COICOP products to time-use activities. For this reason, we carefully construct each relationship by analysing the existing studies together and considering the consumption expenditures of Turkish households.

3.2.1. EXIOBASE to COICOP

The classification of the EXIOBASE dataset is not suitable for attributing products to specific time-use activities (e.g. EX20: 'Anthracite', EX32: 'Uranium and thorium ores (12)'). On the other hand, COICOP is an internationally recognised classification of household expenditure. In their studies, Druckman et al. (2012) and Smetschka et al. (2019) use the COICOP classification to allocate between consumption goods and time-use activities. On these grounds, first, we create a concordance matrix between EXIOBASE products and COICOP products.

Ivanova and Wood (2020) aggregated household consumption survey expenditures under 63 COICOP categories (a combination of two-, three- and four-digit categories). They created a concordance matrix (63x200) in which 63 COICOP categories are apportioned to 200 EXIOBASE categories. We convert Ivanova and Wood's (2020) matrix into EXIOBASE x COICOP format by weighting it proportionally with the consumption expenditures obtained from TURKSTAT HBS.

In order to make the process more understandable, a part from the concordance matrix of Ivanova and Wood (2020) is given in the figure below:

	EX1	EX2	EX3	EX4	EX5	...	EX200	Total
EUR_HE0111	...	...	...	0%	0%	...	...	100%
⋮	...	...	...	...	...	...	...	⋮
EUR_HE0116	0%	0%	0%	100%	0%	...	0%	100%
EUR_HE0117	0%	0%	0%	100%	0%	...	0%	100%
⋮	...	...	...	...	...	...	...	⋮
EUR_HE127	...	...	...	0%	0%	...	...	100%

Figure 3.1. COICOP-EXIOBASE Concordance Matrix, Ivanova and Wood (2020)

As seen in the given part of the concordance matrix, there is a percentage dispersion from COICOP products to EXIOBASE products, and the column totals are equal to one hundred per cent. What is needed is the dispersion of EXIOBASE products to COICOP products.

For example, one hundred per cent of EUR_HE0116 and EUR_HE0117 products goes to EX4 product, and no other COICOP category goes to EX4 product. From this, it can be inferred that product EX4 is associated with these two COICOP categories, but data is not sufficient to distribute the percentages accurately. At this point, we use the consumption expenditures in the 2015 HHBS:

Table 3.4. COICOP Expenditures

COICOP Category	HBS Expenditure (in TL)	Percentage
EUR_HE0116	757063,92	39%
EUR_HE0117	1160256,08	61%
Total	1917320,00	100%

Source: TURKSTAT HBS, 2015

Since there is no other category associated with the EX4 product, we sum up the percentage of the expenditures of only these two related products (since their ratios are as such in Ivanova and Wood's concordance matrix) and proportion according to the expenditures. Thus, we distribute the EX4 proportionally to the two COICOP categories related:

	EUR_HE0111	...	EUR_HE0116	EUR_HE0117	...	EUR_HE127	Total
EX4	0%	...	39%	61%	...	0%	100%

Figure 3.2. EXIOBASE-COICOP Concordance Matrix, author's calculation

As a result of this process, we obtain an optimised concordance matrix (200x67) for Türkiye, in which EXIOBASE categories are distributed proportionally to more than one COICOP category. Some adjustments to the concordance matrix constructed by Ivanova and Wood (2020) and the details of EXIOBASE x COICOP (200x67) concordance matrix are given in *Appendix A*.

3.2.2. COICOP to Time-Use Activities

We use the concordance matrix in Smetschka et al. (2019) as the primary source for matching COICOP products with time-use activities. By combining similar COICOP categories leading to the same time-use activities in the matrix of Smetschka et al. (2019), we obtain a COICOP-Time-use activities concordance matrix (67x21), in which various consumption products were distributed to various time-use activities.

The table below gives some of the consumption product groups to which time-use activities are related according to the functional time-use categories.

Table 3.5. Functional time-use categories and related consumption goods and services

Functional time-use category	Related consumption goods and services
<i>Personal Time</i>	Housing, water, electricity, gas and other fuels; Furnishings, household equipment; Clothing and footwear; personal care products and services; food and beverages etc.
<i>Committed Time</i>	Dwelling maintenance; electricity, gas and other fuels etc; tools and equipment for house and garden; household appliances; cleaning products; medicines and health services etc.
<i>Contracted Time</i>	No consumption.
<i>Free Time</i>	Information and communication equipments and services; cultural goods and services; newspapers, books and stationery; education expenses; catering and accommodation services
<i>Mobility Time</i>	Purchase of vehicles; transport services; fuels etc.

Appendix A contains COICOP categories' emissions calculated using the EXIOBASE-COICOP concordance matrix. It also provides detailed information on how COICOP products are associated with time-use activities.

3.3. Calculating Emissions

The carbon emissions caused by a household can be classified into two separate categories: direct and indirect (embedded) emissions. Direct emissions occur in the use-phase of the product. For example, the use of gas for heating, cooking, and the use of petroleum products for private transport. The emission arising in the production and

distribution process of goods and services purchased by households is indirect emission.

In this study, we obtain direct emissions from the EXIOBASE3 database. The total direct emissions of households in 2015 are 39.8 mt, according to calculations based on EXIOBASE3. Direct emissions are derived from national accounts and, therefore, are not disaggregated by consumption expenditures. Gürer et al. (2024) calculated the shares of direct emissions that can be attributed to mobility and to electricity, gas and other fuels in Türkiye for 2019. Based on this study, we distribute 53 per cent of the total direct emissions caused by households to mobility (21.1 mt) and 47 per cent to electricity, gas and other fuels (18.7 mt).

We also use the EXIOBASE3 database for indirect emission calculations. In EXIOBASE, emission coefficients (kg CO₂ equivalent of CO₂, CH₄, N₂O, and SF₆ emitted by spending one million Euros on any product) are given for each of the 200 products. We multiply the emission coefficient by the final consumption expenditure made by the households to obtain the total indirect emission for each product.

Then, we attribute EXIOBASE emissions to COICOP with the help of the EXIOBASE-COICOP concordance matrix. The indirect emissions of EXIOBASE products in 2015 and the associated COICOP products (including their ratios) are given in *Appendix A*. We calculate the indirect emissions of COICOP products by distributing EXIOBASE emissions according to the ratios given in the table. By including the direct emissions with two groups (mobility & electricity, gas and other fuels), we distribute the total emissions to all COICOP categories. These categories and total emission amounts can be found in *Appendix A*.

Then, we calculate the emission of time-use activities using the COICOP-Time use activities concordance matrix. We calculate the emission intensity of time-use activities per hour using the method used in the study of Jiang et al. (2022). For clarity, Jiang et al.'s (2022) method will be explained below with the help of mathematical notation.

i and j represent consumption items and time-use activities, respectively. In accordance with the COICOP-Time use (67 x 21) concordance matrix, i and j are equal to 67 and 21, respectively. E_i^{tot} , the total emission of consumption item i , is the sum of direct and indirect emissions:

$$E_i^{tot} = E_i^{di} + E_i^{in}$$

E_i^{di} and E_i^{in} , represent the direct and indirect emissions caused by consumption item i , respectively. Variable a_{ij} , i.e. the proportion of time-use activity j in all time-use activities involving consumption item i :

$$a_{ij} = \frac{t_j}{\sum_j t_{ij}}$$

is expressed as above. Variable t_j , is the total time length of activity j ; t_{ij} , is the total time length of activity j involving item i ; $\sum_j t_{ij}$ is the total time length of all activities involving item i . The sum of the proportions of activities j involving consumption item i must equal one:

$$\sum_j a_{ij} = 1$$

The total emission of activity j from consumption of i is the total emission caused by i (E_i^{tot}) multiplied by the usage rate of i in j (a_{ij}). The total emission of activity j , E_j^{tot} , is:

$$E_j^{tot} = \sum_i a_{ij} * E_i^{tot}$$

is obtained by summing the total emissions caused by each product i used in activity j . E_j^{tot} is the total annual emissions for activity j . Dividing E_j^{tot} by the total population in 2015 yields E_j^{tot} per capita. t_j , whose calculation is given in *Appendix A*, is the total annual time spent per capita on activity j .

Finally, by dividing the total emission of activity j by the total length of time spent on activity j , the level of kg CO₂e per hour of activity j is determined:

$$I_j^{tot} = \frac{E_j^{tot} per\ capita}{t_j}$$

In other words, I_j^{tot} is the GHG emission intensity of time-use activity j , per hour. In summary, in line with the general trend in the literature, we distribute the total amount of emissions caused by a consumption item to all time-use activities involving that item in proportion to the length of their duration.



CHAPTER 4

RESULTS

In this section, firstly, we determine the GHG emission intensities of time-use activities and compare the results with the literature. Then, we analyse the time use tendencies of individuals according to the demographic breakdowns in the time use survey. We multiply the daily average time allocated to activities by different groups by the GHG emission intensities of the activities. So, we calculate the daily emissions resulting from that activity and the average total daily emissions of an individual. As a result, it will be possible to identify disadvantaged groups and develop targeted policy recommendations to encourage habits with lower emission intensity.

We analyse the time-use habits of individuals according to their gender, employment status, and marital status. We also analyse these groups in sub-categories by taking gender into account (e.g., employed men, unemployed men, employed women, unemployed women). In addition, we also consider the differences between individuals under and over 40. We cannot find significant differences and produce policy recommendations. Therefore, the results related to age are given in *Appendix B*.

4.1. General Results

We allocate the total direct and indirect emissions of 322.17 million tonnes of CO₂e caused by households in Türkiye to 21 time-use activities in proportion to the time spent on that activity. We calculate the amount of emissions caused by one person by

dividing the total emissions by the population: For 2015, the average annual total emissions per capita was about 4.09 tonnes of CO₂e (322.17 million tonnes/2015 population).

Table 4.1. Time-use activities' total emissions, time and intensity

	Total Emission ¹	Total Emission per Capita ²	Total Time per Capita ³	Intensity ⁴
Eating & Drinking	77.28	0.98	561.43	1.75
Mobility	43.14	0.55	386.81	1.42
Eating out	15.79	0.20	146.37	1.37
Repairs & Gardening	3.52	0.04	39.38	1.14
Personal Care	25.41	0.32	298.18	1.08
Recreational courses & study	4.11	0.05	103.46	0.50
Entertainment & Culture	11.06	0.14	314.84	0.45
Hobbies & Games	2.74	0.03	79.86	0.44
Caring for others	5.85	0.07	172.54	0.43
Cleaning, tidying	8.44	0.11	255.21	0.42
Food Preparation & Dishwashing	12.49	0.16	377.82	0.42
Pet care	0.69	0.01	22.54	0.39
Spending time with family/friends	11.41	0.14	408.38	0.35
Watching TV & Videos/DVDs, Listening to Radio & Music	22.20	0.28	794.40	0.35
Reading	1.72	0.02	61.63	0.35
Sleep and rest	74.07	0.94	3213.70	0.29
Sport & Outdoor Activities	0.58	0.01	70.14	0.11
Shopping, Civic Matters & Services	0.42	0.01	78.60	0.07
Volunteering	1.22	0.02	263.52	0.06
Work (excluded)	0.00	0.00	933.13	0.00
Study (excluded)	0.00	0.00	178.05	0.00

Notes: 1 In million-tonnes CO₂

2 Total Emission / 2015 Population (78741053), in ton CO₂

3 Average annual total time for an activity, in hour, per capita

4 Total Emission Per Capita / Total Activity Time Per Capita, in kg/ CO₂ per hour.

From the time-use survey, we calculate the average number of hours a person spends on an activity per year. By dividing the total emissions per capita (4.09 tonnes CO₂e)

by total hours (24*365 h), the average GHG emission intensity in Türkiye is found to be 0.47 kg CO₂e per hour.

Eating & drinking, mobility, eating out, repairs & gardening and personal care are the activities with the highest GHG emission intensity per hour, respectively. Free time activities such as pet care, spending time with family & friends, reading, sports & outdoor activities, and volunteering are among the activities with low GHG emission intensity.

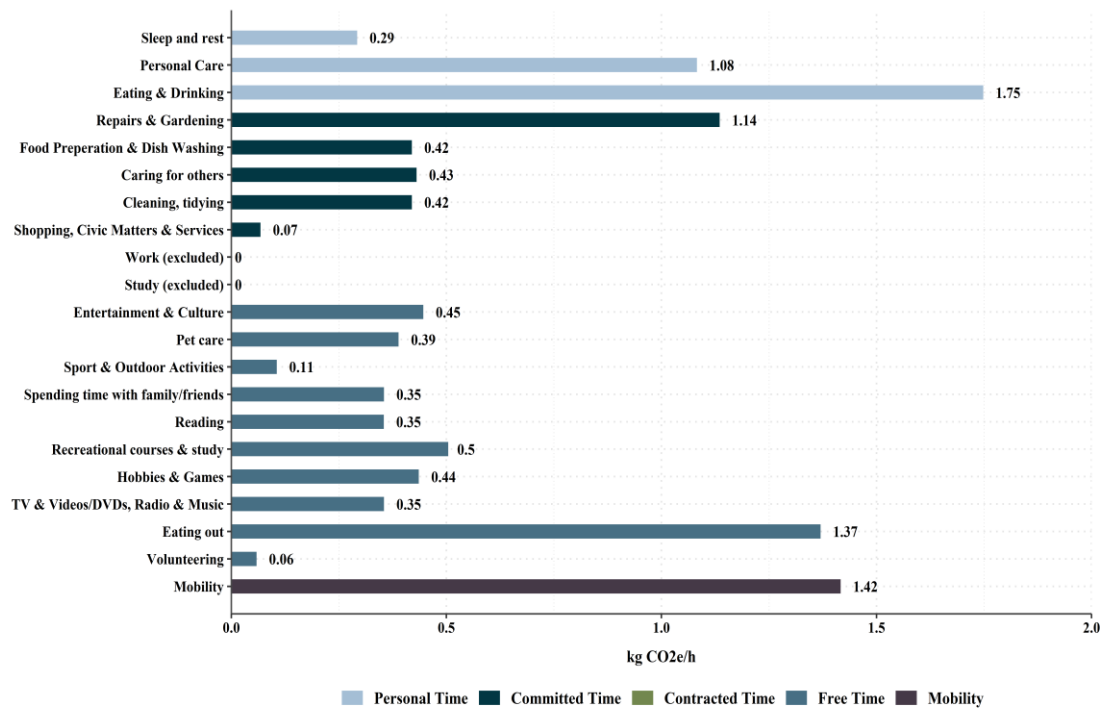


Figure 4.1. GHG emission intensities of 21 time-use activities, kg CO₂e/h

Regarding functional time-use activities, the highest GHG emission intensity per hour is in the mobility category, with 1.42 kg CO₂e. Mobility time takes only 4 per cent of the daily time, while the emissions it causes account for 13 per cent. Second is personal time, which is 0.55 kg CO₂e/h, followed by committed time, which is 0.42 kg CO₂e/h. Free time has the lowest GHG emission intensity with 0.40 kg CO₂e/h.

Total time and emission shares of functional time-use activities are shown in the following figure:

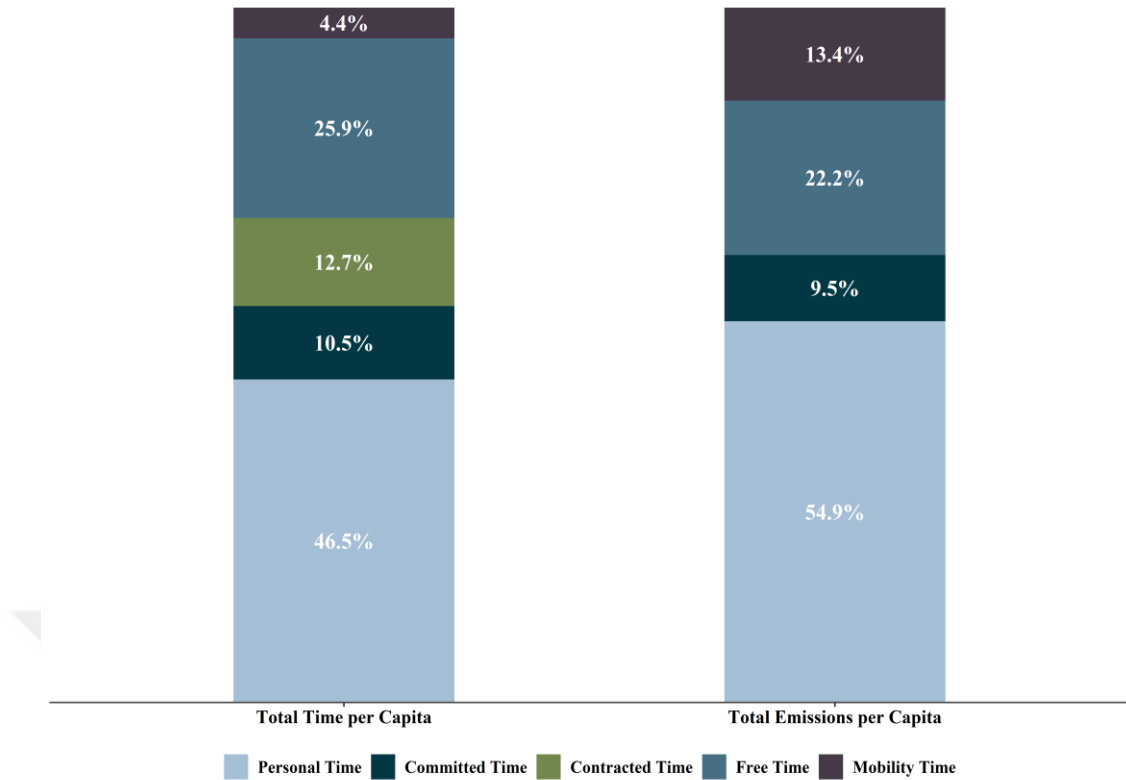


Figure 4.2. Total time and emission shares of functional time-use activities

4.1.1. Comparison with Other Studies

We calculate the average total emissions per day in Türkiye as 11.21 kg CO₂e, and the average emission intensity per hour as 0.47 kg CO₂e/h. The average GHG emission intensity per hour is 1.3, 1.2, and 0.63 kg CO₂e/h for Austria, the UK, and Japan, respectively (Smetschka et al., 2019; Druckman et al., 2012; Jiang et al., 2022). Although the years of input-output models, household budget surveys and time-use surveys vary in all studies, the years focused on when calculating emissions are as follows: 2009-2010 for Austria in Smetschka et al. (2019); 2004 for the UK in Druckman et al. (2012); 2006 for Japan in Jiang et al. (2022).

Our study is comparable to other studies in the literature. Nevertheless, since we use the same allocation between consumption goods and time-use activities as Smetschka et al. (2019), comparing Türkiye and Austria would be more precise. Therefore, GHG emission intensities of time-use activities for Türkiye and Austria are shown in following table:

Table 4.2. GHG emission intensities of time-use activities, Türkiye and Austria, in kg CO₂e/h

Time-use Activity	Türkiye	Austria
Eating & Drinking	1.75	3.30
Eating out	1.37	9.82
Repairs & Gardening	1.14	1.92
Personal Care	1.08	2.67
Recreational courses & study	0.50	3.37
Entertainment & Culture	0.45	9.74
Hobbies & Games	0.44	4.13
Caring for others	0.43	1.79
Cleaning, tidying	0.42	1.51
Food Preparation & Dish Washing	0.42	1.51
Pet care	0.39	1.02
Spending time with family/friends	0.35	1.00
Watching TV & Videos/DVDs, Listening to Radio & Music	0.35	1.00
Reading	0.35	1.05
Sleep and rest	0.29	0.64
Sport & Outdoor Activities	0.11	1.08
Shopping, Civic Matters & Services	0.07	0.85
Volunteering	0.06	0.14

Notes: 1 Austria's GHG emission intensities are based on Smetschka et al. (2019) calculations.

2 The table does not include mobility time.

If we compare the results of Türkiye and Austria; similar free time activities have the lowest GHG emission intensity in both countries. These include volunteering, reading, pet care, sports, spending time with friends and watching TV. Except for repairs & gardening, other committed time activities have the same ranking in GHG emission intensity. Repairs & gardening is one of the most GHG-intensive activities in Türkiye, while it is relatively less GHG-intensive in Austria.

While Türkiye's 2015 GDP per capita was US\$ 11,050, it was US\$ 48,153.3 for Austria in 2009 (World Bank, n.d.). This difference in GDP per capita is reflected in expenditures, leading to an increase in total emissions and thus, in average emission

intensity against Austria while at the same time causing differentiation of activities that affect high GHG emissions. Austria's three most GHG-intensive activities are eating out, entertainment & culture, and hobbies & games. Austria's most GHG-intensive functional time-use category is mobility time (4.9 kg CO₂e/h), followed by free time activities (1.9 kg CO₂e/h). While people in Austria have much money to spend on leisure activities, the highest category per hour in Türkiye is eating & drinking. This points to the challenge of further reducing the carbon footprint of households in developing countries with low GDP per capita.

The fact that the GHG emission intensity of eating out is lower than eating & drinking in Austria, while the opposite is the case in Türkiye is another striking result in the differences between the two countries. A person in Austria causes seven times more emissions in 1 hour spent eating out than a person in Türkiye. The difference in income can also explain it. In Türkiye, the intensity of this category is lower than in Austria because people in Türkiye do not spend much money on eating out and do not consume products with high emission intensity. For example, Türkiye lags behind developed countries in per capita consumption of high GHG-intensive animal products, such as meat and milk (TEPGE, 2018). Additionally, the wine consumption per capita in Türkiye was 0.8 litres in 2015, while it was 32.1 litres in Austria (OIV, n.d.). Therefore, a superficial conclusion should not be drawn from this situation, such as the carbon intensity is lower when eating out rather than at home. Although we calculate a homogenous emission intensity for all groups in this study, it is possible to say that emission intensity changes for different income groups when we compare the results of Türkiye and Austria. The intensity of eating out and entertainment activities will be much higher in high-income groups compared to other groups. We hope to study income-based emission intensities of time-use activities in a future study.

4.2. Gender

Firstly, we analyse the time use tendencies of the genders and the resulting emission differences. The total sample size of the time use survey is 25,109, of which 12,150 are men and 12,159 are women. Sample weights are utilised to construct averages across all demographics.

Table 4.3. Daily time-use patterns and emissions, by gender

		Intensity	Total Time		Total Emission	
			Men	Women	Men	Women
<i>Personal Time</i>	Sleep and rest	0.29	08:44	08:52	2.56	2.60
	Personal Care	1.08	00:51	00:46	0.93	0.83
	Eating & Drinking	1.75	01:23	01:41	2.43	2.95
<i>Committed Time</i>	Repairs & Gardening	1.14	00:08	00:04	0.15	0.09
	Food Preparation & Dish Washing	0.42	00:08	01:54	0.06	0.80
	Caring for others	0.43	00:11	00:44	0.09	0.32
	Cleaning, tidying	0.42	00:06	01:16	0.05	0.54
	Shopping, Civic Matters & Services	0.07	00:12	00:13	0.01	0.02
<i>Contracted Time</i>	work (excluded)	0.00	03:58	01:09	0.00	0.00
	study (excluded)	0.00	00:30	00:28	0.00	0.00
<i>Free Time</i>	Entertainment & Culture	0.45	00:54	00:49	0.40	0.37
	Pet care	0.39	00:04	00:03	0.03	0.02
	Sport & Outdoor Activities	0.11	00:17	00:06	0.03	0.01
	Spending time with family/friends	0.35	01:03	01:10	0.37	0.42
	Reading	0.35	00:09	00:10	0.06	0.06
	Recreational courses & study	0.50	00:15	00:18	0.13	0.16
	Hobbies & Games	0.44	00:19	00:06	0.14	0.05
	Watching TV & Videos/DVDs. Listening to Radio & Music	0.35	02:13	02:07	0.79	0.76
	Eating out	1.37	00:31	00:16	0.72	0.38
	Volunteering	0.06	00:34	00:51	0.03	0.05
<i>Mobility Time</i>	Mobility	1.42	01:20	00:47	1.89	1.11
Total			24 h	24 h	10.88	11.53

Table 4.3 shows the GHG emission intensities of time-use activities (kg CO₂e/h), the time spent by an average man and woman on time-use activities in a day, and the total emissions from these activities (intensity*hour).

The results will be analysed under separate headings according to functional time-use categories. Then, an overall discussion will be given in *section 4.2.6*.

4.2.1. Personal Time

Women, on average, spend 8 minutes more on sleep and rest and 17 minutes more on eating & drinking, while men spend 8 minutes more on personal care daily.

Women emit 0.46 kg/CO₂e in the personal time category more than men. The difference is mainly because women spend more time in the high GHG-intensive eating & drinking category.

4.2.2. Committed Time

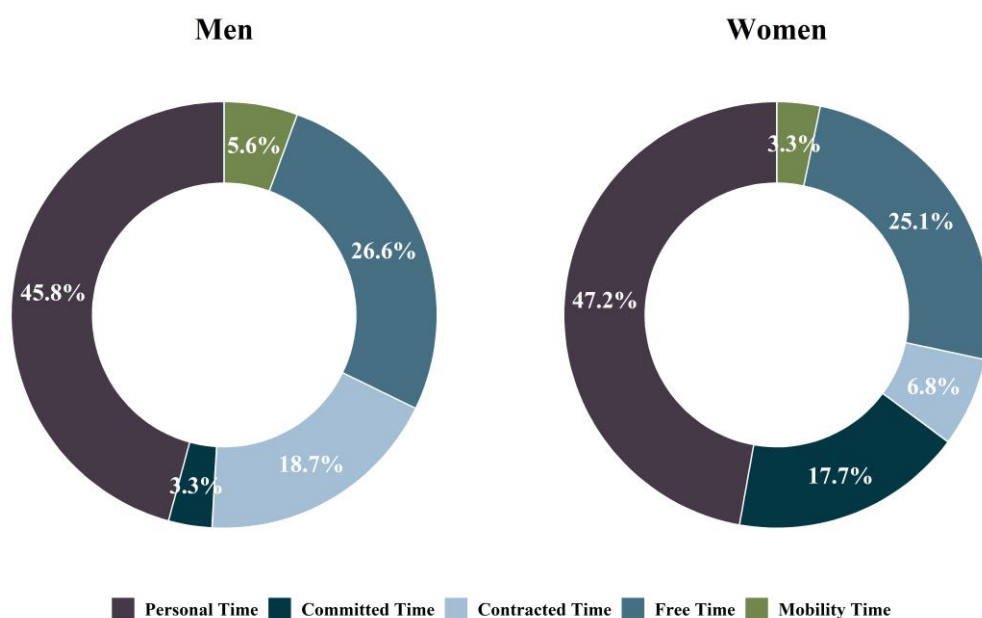


Figure 4.3. Daily time-use by gender, percentile

Committed time activities are the category where gender roles in time-use habits are most apparent. While a woman spends approximately 2 hours of her day on food preparation and washing, 1 hour and 17 minutes on cleaning, and 45 minutes on caring for others, the time allocated to these activities for men is 8, 7, and 12 minutes, respectively. Committed time activities take up 18 per cent of a woman's 24 hours, while they take up only 3 per cent for men.

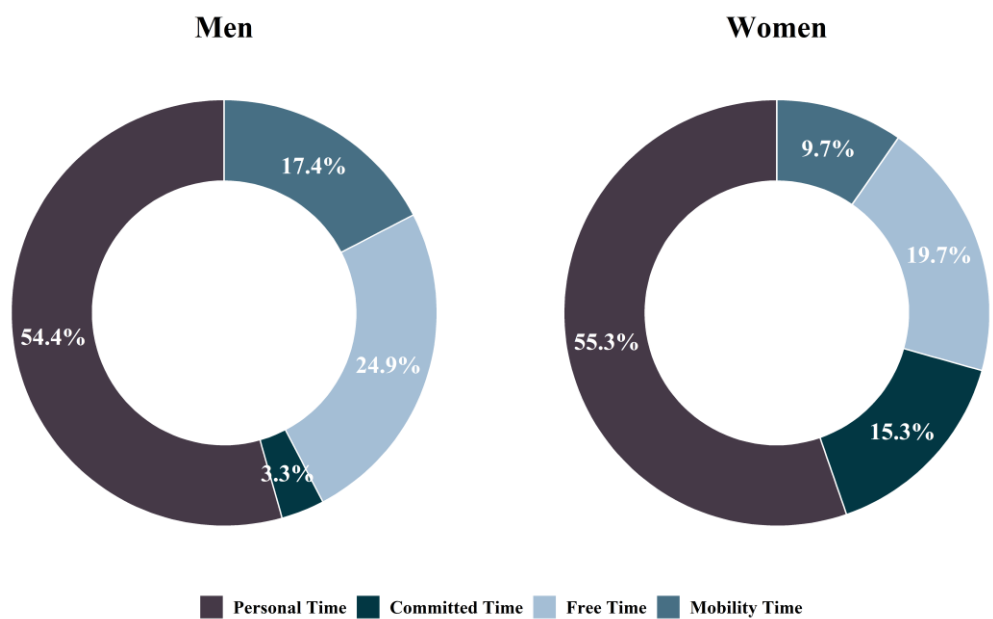


Figure 4.4. Daily emissions by gender, percentile

While men cause an average of 0.36 kg of GHG emissions in a day due to committed time activities, women cause almost five times the men's GHG emissions (1.77 kg). While 3.3 per cent of the total 10.88 kg CO₂e emission caused by men in a day comes from this category, 15.3 per cent of women's daily emissions come from committed time activities. These activities are the main reason women cause more emissions in a day.

Committed time is the most glaring category regarding gender roles. Women appear more susceptible to carbon pricing policies. Therefore, promoting gender equality is crucial for the fair division of environmental burden.

4.2.3. Contracted Time

While a man works on average 4 hours a day, the average working time for women is 1 hour and 10 minutes. The average time allocated for formal education in a day is almost equal for men and women, 28 and 30 minutes, respectively.

4.2.4. Free Time

On average, women spend 17 and 7 minutes more than men on volunteering and spending time with family/friends, while men spend 15, 13, and 10 minutes more on eating out, hobbies & games, and sports & outdoor activities, in a day, respectively. Free time activities cover 25 per cent of a woman's day, compared to 27 per cent for a man. The free time activities account for 24.9 per cent of the total emissions caused by men in a day. Most of the emissions come from watching television and eating out. Women emit 0.44 kg CO₂e less than men in this category, with 19.7 per cent of their daily emissions coming from free time activities. The majority of women's emissions in the free time category also come from watching television, while in the eating-out category, they emit only half as much as men.

4.2.5. Mobility

While men spend 1 hour and 20 minutes per day in mobility, this time is 47 minutes for women. The table below shows how much time is spent travelling for which purpose:

Table 4.4. Mobility time according to purpose, by gender (hour:minute)

	Men	Women
Contracted Time	00:39	00:17
Committed Time	00:09	00:10
Free Time	00:23	00:13
Other	00:08	00:06
Total	01:20	00:47

The primary purpose of travel for both groups is to go to work or school. Nevertheless, men's travelling for contracted time is more than twice as much as women's. In addition, men travel ten more minutes than women for free time activities. The lower participation of women in the labour force and the higher preference of men for free time activities outside the home may be the main reasons for men's higher mobility time. On average, women cause 1.11 kg of GHG emissions from mobility per day (9.7% of women's daily emissions), while this amount is 1.89 kg for men (17.4% of men's daily emissions).

4.2.6. Overall

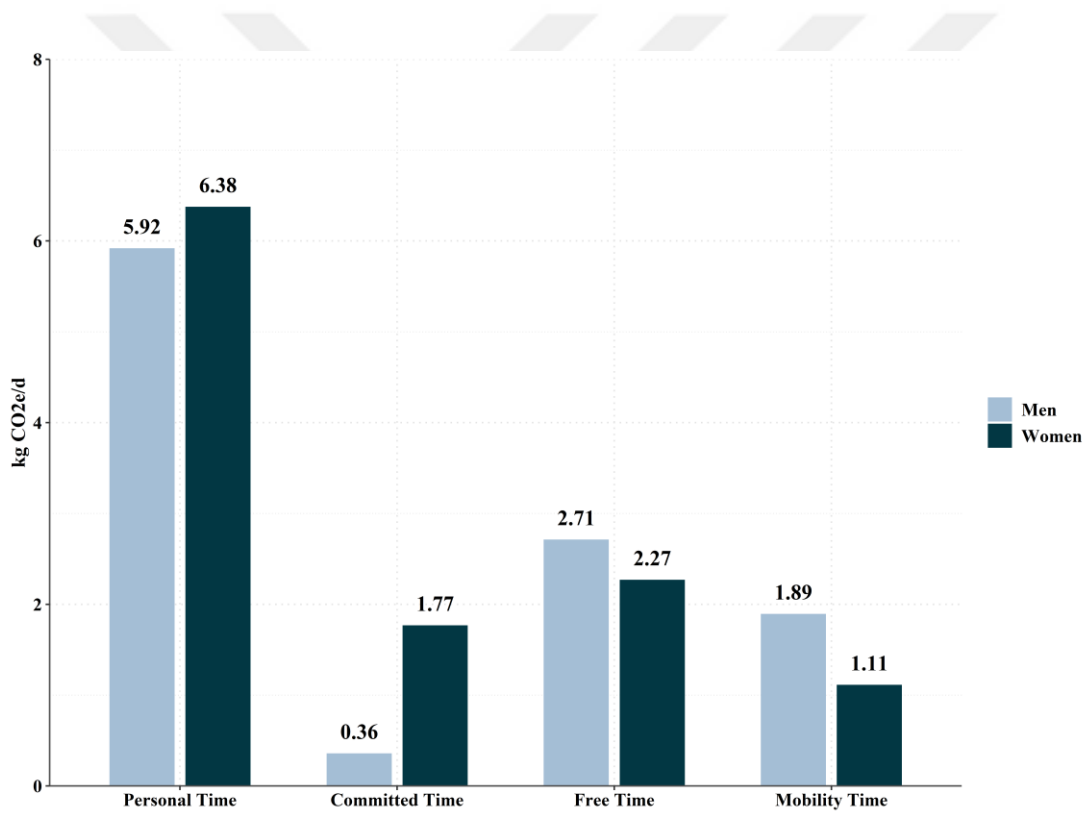


Figure 4.5. Daily emissions by gender, in kg CO₂e

While men emit an average of 10.88 kg CO₂e in a day, women emit an average of 11.53 kg CO₂e. The main reason why women's emissions are higher is the committed time activities in which they perform unpaid domestic labour.

On the other hand, men cause relatively higher emissions due to their high travel time, especially for business purposes. In their free time, they spend more time on relatively high-intensity activities such as eating out, leading to higher emissions. High working hours and more time spent travelling to work may indicate a time squeeze problem for men.

The time squeeze refers to a shortage of time, primarily resulting from working hours and low work-life balances, which causes a squeeze in leisure and household time. It can influence the GHG emission intensity of other activities through the decisions made concerning transport modes, for example, individuals opting for private vehicles rather than public transportation, as well as through consumption patterns, for instance, the consumption of fast food rather than a homemade dish (Smetschka et al., 2019).

4.3 Employment Status

We consider individuals who work part-time (four hours a day on average, five days a week) as employed (or workers). Therefore, if the average daily working hours in a typical week are 2.86 $((5 \times 4)/7)$ and above, an individual is considered to be working. If it is below 2.86, it is considered unemployed (or non-worker). Since employment status was only asked to people aged 16 and over in the dataset, we take people aged 16 and over as a sample when analysing employment status. Total sub-sample size is 22,652. While 7,687 of these people are working, 14,974 people are not working.

Table 4.5. Daily time-use patterns and emissions, by employment status

	Total Time		Total Emission	
	Employed	Unemployed	Employed	Unemployed
Personal Time	09:59	11:37	5.20	6.62
Committed Time	00:54	03:39	0.36	1.56
Contracted Time	07:34	00:39	0.00	0.00
Free Time	04:07	07:09	2.12	2.62
Mobility Time	01:25	00:53	2.01	1.26
Total	24.00	24.00	9.69	12.06

Note: The extended table, which includes data for 21 time-use activities, is available in *Appendix C*.

Personal Time: An unemployed person spends on average, 1 hour more on sleeping and 40 minutes more on eating & drinking in a day than an employed person, while the time spent on personal care is similar for both groups (unemployed: 47 minutes, employed: 50 minutes). In total, non-workers spend 1 hour and 38 minutes more on personal time activities and therefore cause 1.42 kg more GHG emissions in this category than workers. Fifty-four per cent of the daily emissions of workers and 55 per cent of non-workers come from this category.

Committed Time: In all activities in the Committed Time category, non-workers spent more time than workers. While workers spend an average of 54 minutes on committed time activities in a day, this time is 3 hours and 39 minutes for non-workers. Therefore, non-workers emit an average of 1.2 kg CO₂e more per day than workers. 3.7 per cent of the daily emissions of workers and 13 per cent of non-workers come from this category.

Contracted Time: Workers spent an average of 7 hours and 32 minutes per day on the job, compared to 16 minutes for non-workers (not 0, as those with less than 2.86 average daily working hours are considered non-employed). On the other hand, non-workers study for an average of 22 minutes a day, while workers study for only 2 minutes. The relatively low study time is because this sample consists of people aged 16 and above.

Free Time: In all but one of the activities in the free time category, the average daily duration of non-workers is higher. The only free time activity in which workers spend more time is eating out (non-workers: 16 minutes, workers: 41 minutes). As a result, this can hint at a time squeeze problem.

While non-workers spend 7 hours and 9 minutes on average for all free time activities in a day, this time is 4 hours and 7 minutes for workers. When the average intensity of free time activities is 0.40, a difference of 3 hours is expected to result in an average emission of 1.2 kg CO₂e, whereas the difference is only 0.5 kg CO₂e. Non-workers allocate more time to less GHG-intensive leisure activities than workers.

Mobility Time: This is the only category where workers cause more emissions than non-workers. While workers spend an average of 1 hour and 25 minutes daily on mobility, it is 53 minutes for non-workers. 69% of workers' total travel time is for work or school. The most significant share of non-workers' travelling is free time, with 42%.

In total, workers cause 2.01 kg CO₂e emissions due to mobility (21% of workers' daily emissions), while non-workers cause 1.26 kg CO₂e emissions (10% of non-workers' daily emissions).

Table 4.6. Mobility time according to purpose, by employment status (hour:minute)

	Employed	Unemployed
Contracted Time	00:59	00:11
Committed Time	00:06	00:12
Free Time	00:13	00:22
Other	00:05	00:07
Total	01:25	00:53

Overall: A non-working person emits an average of 2.37 kg more GHG emissions per day than a working person. A person's employment status creates the most evident difference in emissions compared to gender, marital status, and age.

The eating out ratio² 0.38 for workers and 0.13 for non-workers. The high amount of time spent at work and travelling to work seems to have caused a time squeeze problem for workers. In their free time, non-workers tend to engage in less GHG-intensive activities.

² eating out time / (eating & drinking time + eating out time)

4.3.1 Employment Status & Gender

In the sub-sample of persons aged 16 and over: working men 5,779, non-working men 5,141, working women 1,899 and non-working women 9,833. 53 per cent of men aged 16 and over are employed, while only 16 per cent of women are employed.

Table 4.7. Daily time-use patterns and emissions, by employment status and gender

		Men		Women	
		Employed	Unemployed	Employed	Unemployed
Total Time	<i>Personal Time</i>	09:57	11:55	10:03	11:27
(hour:min)	<i>Committed Time</i>	00:31	01:10	02:09	04:59
	<i>Contracted Time</i>	07:45	01:01	06:57	00:28
	<i>Free Time</i>	04:18	08:36	03:32	06:23
	<i>Mobility Time</i>	01:27	01:16	01:16	00:41
Total Emissions (kg CO ₂ e)	<i>Personal Time</i>	5.20	6.67	5.21	6.59
	<i>Committed Time</i>	0.21	0.56	0.87	2.09
	<i>Free Time</i>	2.20	3.25	1.83	2.28
	<i>Mobility Time</i>	2.07	1.81	1.80	0.97
Total		9.68	12.29	9.71	11.93

Note: The extended table, which includes data for 21 time-use activities, is available in *Appendix C*.

4.3.1.1. Personal Time

Unemployed men, who are the group that sleeps the most, sleep on average 25 minutes more than unemployed women (9 hours 19 minutes and 8 hours 54 minutes, respectively) while working women sleep 7 minutes more than working men (8 hours 7 minutes and 8 hours, respectively). This may be explained by the fact that employed men have more working hours than employed women, and unemployed men have fewer responsibilities than employed women.

A similar pattern applies to the time spent on personal care: Unemployed men spend the most time on personal care with 54 minutes. In comparison, unemployed women spend 44 minutes on personal care, employed men 49 minutes and employed women

51 minutes. The reason why working women spend more time on this activity than non-working women may be that non-working women spend most of the day at home and, therefore, pay less attention to personal care.

The group that spends the most time on eating & drinking is non-working women with 1 hour 49 minutes. This is followed by non-working men with 1 hour 41 minutes. Although employed men spend more time than employed women, the difference is only 2 minutes (1 hour 7 minutes and 1 hour 5 minutes respectively).

The group that spent the most time on all personal time activities was non-working men, who spent 11 hours and 55 minutes. Non-working women spend 28 minutes less than this group on personal time activities. On the other hand, in the employed group, women spent 6 minutes more than men (10 hours 3 minutes and 9 hours 57 minutes respectively).

The total difference between working and non-working men is almost 2 hours, while the difference between working and non-working women is 1 hour and 25 minutes. Non-working women spend less time on personal time activities than non-working men. Therefore, the group causing the highest emission in this category is non-working men, with an average emission of 6.67 kg CO₂e per day, 1.47 kg more than working men and 0.08 kg more than non-working women. There is almost no difference between working men and women.

4.3.1.2. Committed Time

While non-working men spend the most time on repairs & gardening and shopping, civic matters & services activities, non-working women spend the most time on all other activities in the committed time category.

While non-working women spend almost 5 hours on all Committed Time activities, working women spend 2 hours 9 minutes, non-working men spend 1 hour 10 minutes, and working men spend only 31 minutes. The amount of emissions caused by this time spent are 2.09, 0.87, 0.56 and 0.21 kg CO₂e, respectively.

4.3.1.3. Contracted Time

Employed men and women work on average 7 hours 44 minutes and 6 hours 55 minutes a day, respectively.

Unemployed men and women study for 33 minutes and 17 minutes, respectively. Study time is almost 0 for working men and women. When we calculate for the whole sample, the average time spent on formal education in a day is 29 minutes. Again, for the whole sample, the time spent on education by a man is 30 minutes and by a woman is 28 minutes. However, in this section, where the differences between working and non-working are analysed, the sample includes individuals aged 16 and over. In this sample, while non-working men over the age of 16 study for more than 30 minutes on average, the study time for non-working women over the age of 16 is much below the average.

4.3.1.4. Free Time

The group that spends the most time for all free time activities except eating out is non-working men. Working men spend the most time on eating out with 43 minutes. The second group that spends the most time eating out is working women, with 36 minutes. This is followed by non-working men with 22 minutes, while the group that spends the least time on eating out is non-working women with 13 minutes.

While a non-working man spends 8 hours and 36 minutes on all free time activities, this time is 6 hours and 23 minutes for a non-working woman. Non-working women, who spend 2 hours and 13 minutes less of their day on free time activities than non-working men, spend even more time on committed time activities. Although working men also spend more time on free time activities than working women, the difference is 45 minutes.

In this category, non-working men caused the most emissions, with 3.25 kg CO_{2e} per day. This is equivalent to 26 per cent of all emissions made by a non-working male in one day. While non-working women spend 2 hours and 5 minutes more on free time

activities than working men, their emissions are almost the same (2.28 and 2.22 kg CO₂e, respectively). This is because non-working women spend more time on other leisure activities with lower GHG emission intensity. In comparison, men spend more time eating out, which is one of the most GHG-intensive categories.

4.3.1.5. Mobility Time

The table below shows how much time is spent travelling for which purpose:

Table 4.8. Mobility time according to purpose, by employment status and gender (hour:minute)

	Men		Women	
	Employed	Unemployed	Employed	Unemployed
Contracted Time	00:59	00:16	00:56	00:08
Committed Time	00:06	00:13	00:06	00:11
Free Time	00:15	00:35	00:08	00:14
Other	00:06	00:10	00:04	00:06
Total	01:27	01:16	01:16	00:41

Employed men spend the most time on mobility in a day. Unemployed men spend only 11 minutes less on mobility than employed men, while unemployed women are 35 minutes less mobile than employed women.

Employed women spend 11 minutes less on mobility than employed men. This can be explained by the fact that employed women are closer to their workplace; mobility time for contracted time is 3 minutes less for working women than for working men, and that working men are more likely than working women to be travelling for purposes other than going to work; mobility time for free time is 7 minutes more for working men than for working women.

Unemployed men also spend as much time on mobility as employed women. Non-working men spend 36 per cent of their day, 59 per cent of non-sleeping time, on free time activities and 46 per cent of their travel for free time.

4.3.1.6. Overall

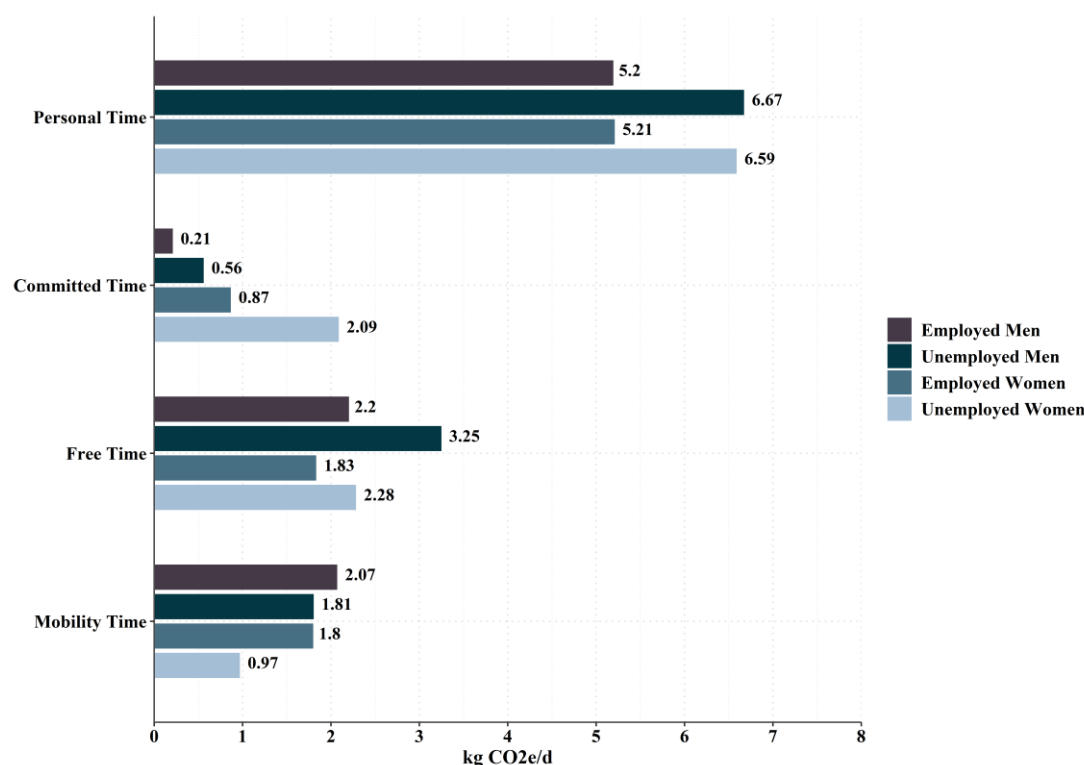


Figure 4.6. Daily emissions by employment status and gender, in kg CO₂e

Among the four groups, the group with the highest emissions in a day is unemployed men with 12.29 kg CO₂e. High time spent on eating and drinking, free time activities and travelling are the sources of the high GHG emissions of non-working men. Especially for this group, which does not have a full-time job and spends little time on domestic chores and therefore has high leisure time, low GHG emission intensity free time activity options in their immediate neighbourhoods should be increased. Especially in big cities, the concentration of cultural, artistic and entertainment activities in certain centres of the city causes emissions and time lost in travelling from distant neighbourhoods to these places. In this respect, spreading such venues and facilities to many parts of the city is vital. Socio-culturally underdeveloped neighbourhoods and districts should be identified.

Unemployed women are the group that causes the highest emissions after unemployed men. They cause an average of 11.93 kg of GHG emissions in a day. Compared to

other groups, their emissions are mostly due to eating & drinking and committed time activities. Although they do not have a full-time job, they perform unpaid labour almost full-time. They spend 4.3 times on committed time activities as non-working men and cause 3.74-fold emissions. This may lead to a time squeeze problem for women who do not work.

Employed women cause 9.71 kg of CO₂e emission in a day. The responsibility of women who work for about 7 hours during the day does not end when they come home; they spend about 2 hours more on cooking, cleaning, and child and elderly care. Men, who work about 50 minutes more than women on average, spend about 1 hour and 40 minutes less than women for the same tasks when they come home. This unpaid domestic labour that falls on wage-earning women creates a burden on women; working women cut back on their leisure time to do these jobs and cause more GHG emissions. This situation is called double burden or second shift. This burden increases even more for married working women. While married working women work for an average of 6 hours and 44 minutes a day, they spend 2 hours and 52 minutes on committed time activities. This is 43 minutes more than the average for all working women. For married working men, while working time is almost unchanged, the time spent on committed time activities is 35 minutes per day. This is only 4 minutes more than the average for all working men. The fact that the working hours of married working women are lower than the average of working women may be because a more significant proportion of women turn to part-time jobs due to the domestic responsibilities they have to undertake. The gender roles become sharper, especially in the institution of marriage, and this situation increases the burden on women even more. Daily time-use patterns and emissions of married employed men and married employed women are given in *Appendix C*.

Employed men are the group that causes the least GHG emissions with an average of 9.68 kg of GHG emissions per day. This group, which spends most of its time sleeping and working, did not find much of a gap to cause extra GHG emissions. However, working men have the highest eating out ratio of 0.40. This ratio is 0.35 for working women, 0.17 for non-working men and 0.10 for non-working women. Higher time

spent on mobility and more working hours may have led to the problem of time squeeze in working men.

4.4. Marital Status

There are four answers to the marital status question in the time-use questionnaire: never married, married, divorced and deceased. In this study, those who answered married are considered married, and the others are considered single.

The total sample size is 25,109, of which 9,875 are single and 15,234 are married.

Table 4.9. Daily time-use patterns and emissions, by marital status

	Total Time		Total Emissions	
	Single	Married	Single	Married
Personal Time	11:34	10:51	6.15	6.15
Committed Time	01:29	03:17	0.62	1.39
Contracted Time	03:08	02:58	0.00	0.00
Free Time	06:43	05:49	2.79	2.27
Mobility Time	01:03	01:03	1.50	1.50
Total	24.00	24.00	11.07	11.31

Note: The extended table, which includes data for 21 time-use activities, is available in *Appendix C*.

Personal Time: A married person sleeps 49 minutes less, spends 7 minutes less on personal care and eats 13 minutes more than a single person. In total, they spend about 43 minutes more for personal time activities, but since most of this time comes from sleep, the amount of emissions they cause in this category is the same.

Committed Time: This is the functional time-use category where single and married people show the biggest difference in time use and, therefore, emissions. Without exception, married people spend more time on all time-use activities under this category. While a married person spends an average of 1 hour and 47 minutes more on committed time activities than a single person, he/she emits 0.77 kg more CO₂e from these activities.

Contracted Time: A married person works 58 minutes more than a single person on average, per day. While singles spend an average of 1 hour and 8 minutes a day on formal education activities, this time is an average of 1 minute for married people. Married people almost never attend formal education.

Free Time: Singles spend more time on all free time activities except volunteering, spending time with family & friends, and pet care activities.

A single person spends an average of 55 minutes more on free time activities than a married person, causing 0.52 kg more CO₂e emissions.

Mobility Time: The time spent on mobility time activity does not differ between single and married people. Both groups cause 1.5 kg of GHG emissions per day in this category.

The details of the time spent on travelling activity are as follows:

Table 4.10. Mobility time according to purpose, by marital status (hour:minute)

	Single	Married
Contracted Time	00:32	00:24
Committed Time	00:06	00:12
Free Time	00:16	00:19
Other	00:07	00:06
Total	01:03	01:03

Overall: A married person emits 0.24 kg more GHG emissions than a single person, on average, per day.

4.4.1 Marital Status & Gender

In the sample, 4,695 men are single, 7,455 are married, 5,180 women are single, and 7,779 are married.

Table 4.11. Daily time-use patterns and emissions, by marital status and gender

		Men		Women	
		Single	Married	Single	Married
Total Time	<i>Personal Time</i>	11:21	10:42	11:48	10:59
(hour:min)	<i>Committed Time</i>	00:37	00:55	02:21	05:34
	<i>Contracted Time</i>	04:01	04:49	02:14	01:11
	<i>Free Time</i>	06:44	06:07	06:43	05:31
	<i>Mobility Time</i>	01:15	01:24	00:52	00:43
Total Emissions (kg CO ₂ e)	<i>Personal Time</i>	5.92	5.92	6.39	6.37
	<i>Committed Time</i>	0.28	0.42	0.97	2.33
	<i>Free Time</i>	2.92	2.56	2.66	1.99
	<i>Mobility Time</i>	1.77	1.99	1.23	1.03
Total		10.88	10.89	11.25	11.72

Note: The extended table, which includes data for 21 time-use activities, is available in *Appendix C*.

4.4.1.1. Personal Time

Among the four groups, single women sleep the most (9 hours 22 minutes), while married men sleep the least. Married women spend the least time on personal care (40 minutes). The other three groups spend very similar time on this activity (approximately 50 minutes).

Single men spend the least time on eating & drinking (1 hour 17 minutes), while married women spend the most time on this category (1 hour 47 minutes). The emissions caused are the same for single and married men (both 5.92 kg/ CO₂e), while single women (6.39 kg CO₂e) are slightly higher than married women (6.37 kg CO₂e).

4.4.1.2. Committed Time

In the committed time category, where the gender difference is most evident, married women spend 5 hours and 34 minutes, more time than a married man spends working on an average day (4 hours and 49 minutes). For this activity, they cause 7.3 times more than a single man, 4.5 times more emissions than a married man and 1.40 times

more emissions than a single woman. When a man gets married, the total time allocated for committed time activities in a day increases from 37 minutes to 55 minutes; when a woman gets married, the time allocated for these activities increases from 2 hours 21 minutes to 5 hours 34 minutes. The gender roles attributed to men and women show themselves very clearly, especially within the institution of marriage. Unfortunately, women spend time on cooking, cleaning and caring for others when they could be working, studying, being productive or spending time on themselves and their hobbies. Municipalities, in particular, have a great deal of work to do for housework, which is a major obstacle to women's participation in the labour force and which they carry as a burden on their backs. This burden should be eased especially on married women by utilising economies of scale.

4.4.1.3. Contracted Time

The working time of married and single women is almost the same, with married being 1 hour 9 minutes, and single being 1 hour 8 minutes. The reason for this is that there are individuals under the age of 18 in the sample; most of them are not working (the question of working is not asked of those under the age of 16), and they are single. It can be assumed that single women over 18 work more than married women. On average, married women study for 1.8 minutes a day, while single women study for 1 hour and 6 minutes. A similar situation is also valid for men: married men study for only 0.6 minutes a day, while single men study for 1 hour and 10 minutes. On the other hand, while single men work for 2 hours and 50 minutes a day on average, this duration is 4 hours and 49 minutes for married men.

4.4.1.4. Free Time

The total time spent on free time activities is almost the same for single women and men: 6 hours 43 minutes and 6 hours 44 minutes, respectively. For married men, this time is 37 minutes less than for single men, while for married women, the time spent on free time activities decreases by 1 hour and 12 minutes on average. In the free time category, most of the time for all groups comes from watching TV & videos/DVDs, listening to radio & music. While married women spend the most time volunteering

and spending time with family/friends activities, single men spend the least time on these activities. The free time activities that single men spend more time than other groups are entertainment & culture (59 minutes), sport & outdoor activities (25 minutes), hobbies & games (33 minutes). Married women spend the least time on these three activities: 44 minutes, 4 minutes and 1 minute, respectively. There is such a contrasting pattern in how single men and married women prefer to spend their free time. In addition, single women read the most (17 minutes), while married women read the least (5 minutes). Single women spend the most time on recreational courses & study activities with 42 minutes. Single men with 34 minutes follow this, while married women and men spend 1 and 2 minutes for this activity, respectively. Married men eat out 4 minutes more than single men (33 and 29 minutes), while the opposite is true for women: Married women eat out 4 minutes less than single women (14 and 18 min).

In this category, single men cause the highest emissions (2.92 kg CO₂e). This is followed by single women (2.66 kg CO₂e), while married women, who spend the least time on leisure activities, cause the least emissions (1.99 kg CO₂e).

4.4.1.5. Mobility

Married men spend an average of 1 hour and 24 minutes per day on mobility time, while it is 1 hour and 15 minutes for single men, 52 minutes for single women and 43 minutes for married women.

Table 4.12. Mobility time according to purpose, by marital status and gender (hour:minute)

	Men		Women	
	Single	Married	Single	Married
Contracted Time	00:38	00:39	00:25	00:10
Committed Time	00:05	00:12	00:07	00:12
Free Time	00:21	00:24	00:12	00:14
Other	00:09	00:08	00:06	00:05
Total	01:15	01:24	00:52	00:43

Married men and women are more likely to travel for committed time than single men and women. While the time taken to work/school is almost the same for married and single men, a married woman travels 15 minutes less for work/school than a single woman. The group travelling the most for free time purposes are married and single men, respectively.

About 18% of the total emissions caused by married men in a day come from the mobility category, compared to 16% for single men, 11% for single women and 9% for married women.

3.4.1.6. Overall

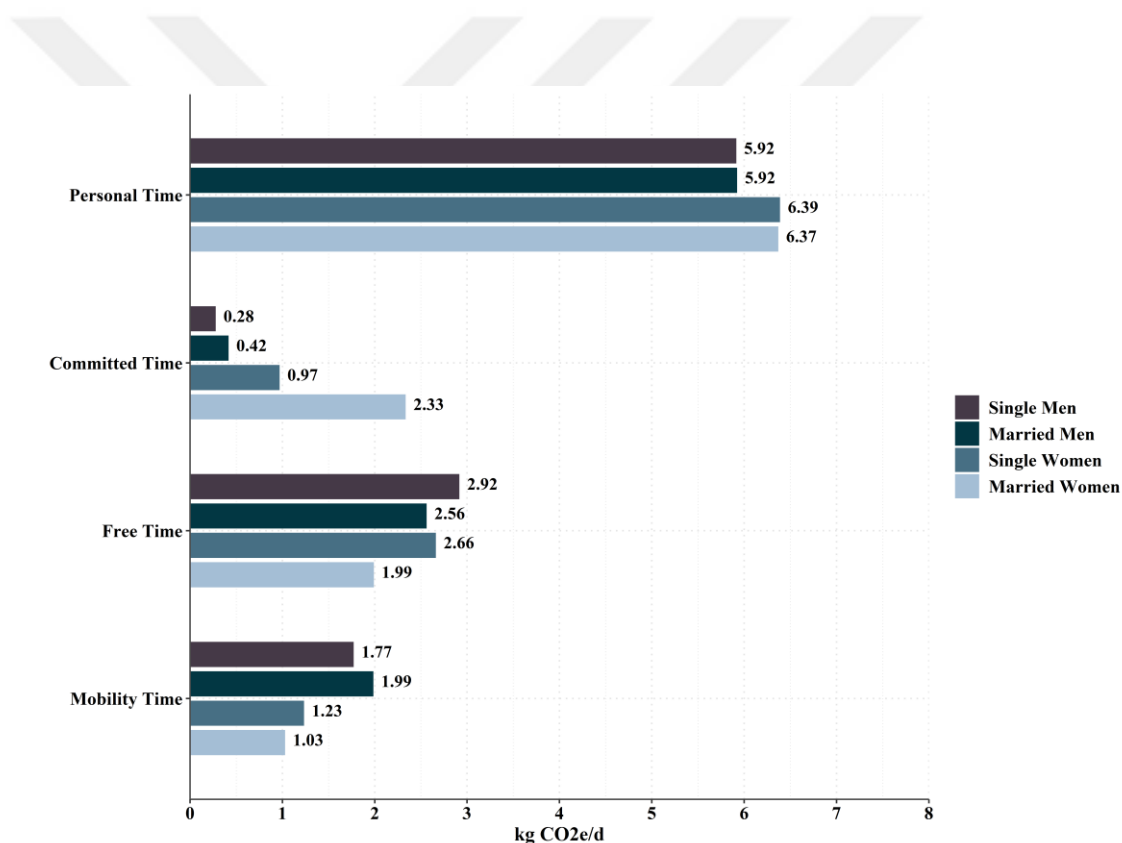


Figure 4.7. Daily emissions by marital status and gender, in kg CO₂e

In total, married women are the group causing the highest daily emissions. The reason why married women emit a total of 0.47 kg more GHG emissions than single women, who emit more in all other categories, is the high emission from the

committed time category. A similar situation exists between single women and married/single men. Committed time activities are a category that needs to be addressed explicitly for women, especially married women.

On the other hand, for men, being married or single is almost indistinguishable in terms of daily emissions. Although the emissions of married men are slightly higher due to emissions from committed time and mobility time activities, the relatively high emissions of single men in free time make up the difference.



CHAPTER 5

MAIN LESSONS & POLICY IMPLICATIONS

Based on the findings of the *Results* chapter, there we have four main policy recommendations.

The first one is related to eating & drinking activity, which causes the highest annual emissions and has the highest GHG intensity. Twenty-four per cent of the daily emissions of an average person in Türkiye come from eating & drinking. This rate increases to 29 per cent when eating out is included. Therefore, the priority should be to reduce the GHG intensity of food and beverages by increasing renewable energy sources and promoting green practices in agriculture. The primary source of greenhouse gas emissions in agriculture is methane produced by cows (Murphy et al., 2013). There are a variety of strategies to reduce methane produced, but it is critical to find solutions that can be implemented without any welfare loss. For example, feed supplements or improving herd health can both improve animal welfare and effectively reduce greenhouse gas emissions (Beauchemin et al., 2011; Llonch et al., 2017).

The second proposal targets the working group. High working hours and travelling time to work may lead to time squeeze and cause people to turn to more GHG-intensive activities. The fact that eating out time is higher in working men than other groups may indicate this. Using private cars instead of public transport to save time on travelling can be the result of the time squeeze problem. Suggestions to reduce the emissions from this situation are shortening working hours, making remote working more widespread and improving public transport systems to make them more

convenient. Although we have not analysed regional differences because of the lack of location information in the time use survey, it is a known fact that people spend most of their day on the road, especially in big cities like Istanbul. According to Gürsoy et al. (2016), while approximately 52% of a driver's travel time in Istanbul in the morning is due to traffic congestion, this rate increases to 58% in the evening. Therefore, it may also benefit the environment by stimulating reversed migration by spreading the clustered industry to different cities in the long term.

The third target group is women. The amount of time women spend on unpaid domestic labour such as cleaning, dishwashing, cooking, and child and elderly care is very high compared to men. Especially unemployed women and married women spend almost as much time as a full-time job. Working women also undertake these tasks as second shifts. Women not only cause high emissions due to these activities themselves but also face the problem of possible time squeeze. Local governments have a crucial role to play here. Providing child and elderly care services and meals for primary school children, especially in low socio-economic areas, will reduce the burden on women and leave time for women to devote to lower-intensity free time activities. These services will also help reduce emissions in total owing to economies of scale. Women unable to work due to childcare may be reintegrated into the labour force, which will also be an economic contribution. In the long term, efforts should be made to eliminate gender inequality through education and awareness-raising activities.

The fourth and final target group is unemployed men. This group, which does not have a full-time job and spends little time on domestic work and therefore has too much free time, causes higher emissions compared to other groups in terms of free time activities and the time travelled for this purpose. For this reason, it is essential to identify the socio-culturally underdeveloped districts, where culture and arts activities do not occur frequently and which have a low park area per capita, and to expand such places and facilities. Also, such activities should be subsidised by the governments. In this way, the number and variety of free time activities with low GHG intensity will increase, the accessibility of different segments will be facilitated, and the emissions caused by travelling will be reduced. This will not only be helpful for the emissions of the unemployed men but also for the employed individuals by directing their free time

towards less GHG intensive activities. Urban green spaces can be the foremost public service to be focused on for both having a pleasant time, benefiting nature, and having a low cost. Increasing the number of theatres, libraries, and free public education courses is also advisable. Local governments have much work to do to identify the districts in disadvantage and take the necessary actions.



CHAPTER 6

LIMITATIONS

The main difficulty in this study arises from the combination of three different data sets. The main limitation of this study is that there is no universally accepted method in the literature for constructing concordance matrices created to harmonise these data sets, and this mapping is, to a degree, arbitrary.

A limitation of the EXIOBASE-COICOP concordance matrix is that EXIOBASE expenditures are in terms of basic price, and household consumption expenditures are in terms of consumer price. Since the tax, trade and logistic margins of the consumption products in the household budget survey are not known, we cannot calculate the consumption expenditures of these products in terms of basic price. Therefore, we prepare the concordance matrix assuming the difference in tax, trade and logistics margins between products is negligible.

The time-use survey only covers individuals over the age of 10. However, the calculated emissions are for the entire population. We match the two datasets by dividing per capita emissions by per capita time-use. Consequently, we assign, for example, the emissions caused by the food consumed by children under ten years old to individuals over ten. Similarly, the emissions from dishwashing or laundry due to children are assigned to adults. We believe this approach is reasonable since the amount of food and clothes consumed by children under ten years old is generally decided by their parents.

Another assumption is that the intensity of activities is proportional to the activity duration and is assumed to be the same for everyone. Since the consumption pattern varies, especially in different income groups, the amount of emissions from the same activity in an hour will also differ. For example, Jiang et al. (2022) created three different tables considering different lifestyles (such as single-person households and families with children) and chose the most appropriate one to minimise mismatching. Nevertheless, since it is impossible to fully reflect the habits of various lifestyles in the model, we assume a homogenous emission intensity. In future studies, we hope to estimate different emission intensities for different income groups.



CHAPTER 7

CONCLUSION

This study analyses the GHG emissions caused by Turkish households from a time-use perspective in order to provide demand-side recommendations for carbon footprint reduction efforts and to understand the environmental impacts of various lifestyles.

Firstly, we construct an EXIOBASE-COICOP concordance matrix (200x67) with the assistance of Ivanova and Wood's COICOP-EXIOBASE Concordance Table (67x200) and consumption expenditures of COICOP products obtained from HBS. We distribute indirect emissions of 200 EXIOBASE products to 67 COICOP products by using this concordance matrix. We allocate 53 per cent of the direct emissions to mobility and 47 per cent to electricity, gas, & other fuels. Thus, by merging direct and indirect emissions, we calculate the total emissions of the products. Then, using the COICOP-Time Use Concordance Matrix from Smetschka et al.'s (2019) study and Jiang et al.'s (2022) specified method, we distribute the emissions of consumption products to the time use activities in proportion to the length of the activity. We divide the total annual emissions of 21 time-use activities by the annual activity duration to calculate the GHG intensity of the activities per hour (kg CO₂e /h).

The average GHG intensity per hour in Türkiye is 0.47 CO₂e /h based on the abovementioned calculations. Compared to other studies, we determine that households in Türkiye cause much less emissions than in developed countries, and the GHG intensity of activities is much lower. Moreover, the most GHG-intensive activity is eating & drinking. The GHG intensity of eating & drinking should be reduced by

increasing sustainable practices in agriculture such as feed supplements and improving herd health.

The analysis of the time use tendencies of individuals according to the demographic breakdowns in the time use questionnaire reveals that the time squeeze problem is detected in working men due to high working hours and time spent on mobility time and in women due to the time spent on unpaid domestic labour. Unemployed women spend almost as much time on committed time activities as working men spend at work. Even if women are in the workforce, this burden is not shared equally between men and women, and women perform a second shift at home.

Individuals experiencing time squeeze may turn to less environmentally friendly alternatives due to their faster consumption and transport preferences. To prevent this, our main recommendations are to reduce working hours, make the remote working model widespread, and utilise economies of scale to reduce women's domestic burden (opening daycare centres, providing elderly care services, etc.). Distributing clustered industrial centres all over the country to solve the transportation problems arising from the high population in big cities; and raising public awareness for the fair sharing of the environmental burden on women between genders are the solution suggestions that should be focused on in the long term.

Men who do not work have been identified as a group that causes high emissions for the leisure time they have and for accessing free time activities. The dissemination of places and activities such as parks, libraries, theatres, art, and public education centres, especially in regions with low socio-cultural levels, and government subsidies on these activities will enable both unemployed men and the whole society to spend their leisure time with nearby, quality, and environmentally friendly activities.

In developing countries like Türkiye, which spend most of their time on work, housework and transport, and where the intensity of time-use activities per hour is already much lower than in developed countries, the opportunities for emission reduction through the time-use composite are less than in developed countries. Nevertheless, everything possible should be done to reduce GHG emissions in the

combat against climate change. This study provided several macro- and micro-level policy recommendations to reduce individuals' carbon footprints and an opportunity to approach environmental problems from a refreshing perspective.



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APPENDICES

A. DATA MANIPULATION

Appendix A.1.

In the TURKSTAT Time Use Survey, the options offered to the respondents to the question of what they were doing are given in the TURKSTAT Activity Categories column in the table below with the activity codes. The table also shows the mapping of these activities to the 21 main time-use activities considered in this study.

Table A.1. Aggregation of TURKSTAT Activities under 21 Time-use Activities

Time-use Categories	TURKSTAT Activity Categories
Sleep and rest	011 Sleep / 012 Patient, lying in bed
Personal Care	031 Washing and dressing / 039 Other or unspecified personal care
Eating & Drinking	021 Eating (if the answer to the question of where is at home)
Repairs & Gardening	341 Gardening / 349 Other or undetermined gardening and animal care / 351 Construction and renovation work related to housing / 352 Repairs related to housing / 353 Construction, repair and maintenance of household goods / 354 Maintenance of vehicles by household members / 359 Other or undetermined construction and repairs (activities not explicitly recorded)
Food Preparation & Dish Washing	311 Food preparation, cooking and serving / 312 Dishwashing
Caring for others	300 Unspecified household and family care (unspecified activities) / 381 Physical care and supervision / 382 Educating a child / 383 Reading, playing and talking with a child / 384 Accompanying a child / 389 Other or unspecified childcare / 391 Assistance to a dependent adult family member / 392 Assistance to a dependent older adult family member / 399 Assistance to an adult family member

Table A.1 (cont'd)

Cleaning, tidying	321 Household cleaning / 322 Garden cleaning / 323 Heating and water / 324 Miscellaneous arrangements / 329 Other or unspecified household maintenance services / 331 Washing / 332 Ironing / 333 Handicraft and fabric production / 339 Other and unspecified fabric production and care / 371 Household management
Shopping, Civic Matters & Services	361 Shopping / 362 Commercial and administrative services / 363 Services for persons / 369 Other or unspecified shopping and services
work (excluded)	111 Time spent in main and secondary employment / 121 Lunch break / 129 Other employment-related and unspecified activities
study (excluded)	200 Unspecified educational and training activities / 211 Specified activities related to school and university
Entertainment & Culture	521 Cinema / 522 Theatres and concerts / 523 Art exhibitions and museums / 524 Library / 525 Sports competitions / 529 Other or undetermined leisure and cultural activities / 531 Rest and recreation (leisure time) / 721 Computer use and programming / 722 Obtaining information by computer / 723 Communication by computer / 729 Other or undetermined computer use activities
Pet care	342 Care of tame animals (other than agricultural operations) / 343 Care of pets such as cats, dogs, birds, etc.
Sport & Outdoor Activities	344 Walking the dog / 611 Walking and nature walks / 612 Light jogging and running / 613 Cycling, skiing and ice skating (for exercise) / 614 Games with a ball / 615 Gymnastics and fitness (at home or in a gym) / 616 Water sports / 619 Other or undetermined physical exercises / 621 Productive exercises (hunting, fishing, mushroom picking, etc.) / 631 Sports-related activities
Spending time with family/friends	511 Socialising with family / 512 Visiting and entertaining guests / 513 Celebrations / 514 Telephone calls / 519 Other or unspecified social life
Reading	811 Reading periodicals / 812 Reading books / 819 Other or unspecified reading
Recreational courses & study	212 Homework / 221 Free time study
Hobbies & Games	711 Art (Visual, Performing and Literary Arts) / 712 Making collections / 713 Correspondence / 719 Other or unspecified hobbies / 731 Solo games and games of chance / 732 Arcade games / 733 Computer and video games / 739 Other or unspecified games
Watching TV & Videos/DVDs, Listening to Radio & Music	821 Watching TV, video or DVD / 831 Listening to radio and cassette tape
Eating out	021 Eating (if the answer to the question of where is not at home)
Volunteering	411 Work provided for an organisation / 421 Construction and repairs as assistance / 422 Assistance in employment and farming / 423 Childcare as assistance to own child living in another household / 424 Childcare as assistance / 425 Assistance to an adult member of another household / 429 Other or unspecified informal assistance (to another household) / 431 Meetings / 432 Religious activities / 439 Other or unspecified voluntary activities

Table A.1 (cont'd)

Mobility	910 Travel to/from work / 920 Travel to/from school/university / 936 Travel related to shopping and services / 938 Travel related to childcare / 939 Travel related to other household care / 940 Travel related to voluntary work and meetings / 950 Travel related to social life / 960 Travel related to other leisure / 980 Travel for relocation purposes / 900 Other or unspecified travel / 995 Filling in time-use diary / 998 Unspecified leisure activities / 999 Other unspecified time use
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Note: We translated the category names as the microdata recording pattern, which was kept in Turkish by TURKSTAT.

Appendix A.2.

In this section, the modifications made to the concordance matrix of Ivanova and Wood (2020) are explained in detail. Then, the EXIOBASE emissions and the COICOP products that are related to according to the EXIOBASE-COICOP concordance matrix (200x67) obtained in this study are given in Table A.2. By distributing EXIOBASE emissions to the relevant COICOP categories, we calculate the emissions of COICOP products. The results are shown in Table A.3.

Modifications on Ivanova and Wood's concordance table can be listed as follows:

- Gürer et al. (2024) made some adjustments to the compatibility matrix of Ivanova and Wood (2020) by taking into account the household behaviour in Türkiye (e.g. more widespread use of LPG as personal transport equipment in Türkiye, non-use of nuclear energy in electricity generation in Türkiye, etc.). As a result, they obtain a matrix in which the expenditures of 67 COICOP products were distributed to EXIOBASE products instead of 63. We use the Gürer et al. (2024) version of Ivanova and Wood's (2020) transformation matrix with additional adjustments.
- In Gürer et al.'s study, the sources of electricity generation (coal, hydro, wind, etc.) were calculated based on the Republic of Türkiye Energy Market Regulation Authority (TR EMRA) 2019 data. EUR_0451 Electricity expenditures were distributed to the relevant EXIOBASE categories (from

EX128 to EX141) by the obtained ratios. We recalculate the ratios according to 2015 TR EMRA data. However, this modification did not change the GHG intensities of time-use activities.

- In the concordance matrix of Ivanova and Wood, 22% of the "EUR_043 Maintenance and repair of the dwelling" emissions goes to the "EX141 - Distribution and trade services of electricity" EXIOBASE category. Accordingly, in our EXIOBASE-COICOP concordance matrix (200x67), 35% of the 17.8 mt of emissions of EX141 goes to EUR_043 and the rest to "EUR_HE0451 Electricity" category. In the COICOP-Time Use concordance matrix (67x21), EUR_043 is only associated with the "repairs and gardening" activity. An emission of approximately 6.2 mt ($17.8 * 0.35$) from this COICOP product alone is attributed to the repairs and gardening activity. Resultantly, the emission intensity of the repairs and gardening category is calculated as 3.06. This result is inconsistent with the literature, and it is not reasonable to attribute the emissions from electricity distribution only to repairs and gardening. For these reasons, we zero out the 22% from EUR_043 to EX141 and distribute proportionally the whole amount to other related EXIOBASE categories.

The indirect emissions of EXIOBASE products and the EXIOBASE-COICOP concordance matrix are listed in the table below. We calculate emissions using EXIOBASE3 for 2015 Türkiye. The table does not include EXIOBASE products with emissions of 0 or very close to 0.

Table A.2. EXIOBASE indirect emissions by households for Türkiye, 2015, and related COICOP categories

EXIOBASE	Emissions, in mt	COICOP
ex4	4.14	EUR_HE0117 (61%). EUR_HE0116 (39%)
ex5	0.0019	EUR_HE0115
ex7	0.25	EUR_HE0119
ex8	1.16	EUR_HE0111

Table A.2 (cont'd)

ex13	0.27	EUR_HE0112
ex14	0.21	EUR_HE0114
ex18	1.60	EUR_HE04549 (88%). EUR_HE043 (12%)
ex19	0.13	EUR_HE093
ex21	0.02	EUR_HE04541
ex22	1.37	EUR_HE04542
ex43	0.37	EUR_HE0112
ex44	0.0019	EUR_HE0112
ex45	0.03	EUR_HE0112
ex46	0.03	EUR_HE0112
ex47	0.58	EUR_HE0115
ex48	2.36	EUR_HE0114 (64%). EUR_HE0118 (19%) .EUR_HE0115 (17%)
ex49	0.69	EUR_HE0111
ex50	0.14	EUR_HE0118
ex51	45.80	EUR_HE0111 (58%). EUR_HE0112 (14%). EUR_HE0119 (11%). EUR_HE012 (11%). EUR_HE0118(4%). EUR_HE021 (2%)
ex52	2.94	EUR_HE012 (85%). EUR_HE021(15%)
ex53	2.63	EUR_HE0113
ex54	1.19	EUR_HE022
ex55	1.54	EUR_HE031 (64%). EUR_HE052 (17%). EUR_HE043 (10%). EUR_HE0561 (5%). EUR_HE0512 (2%). EUR_HE1232 (2%)
ex56	13.31	EUR_HE031 (73%). EUR_HE032 (27%)
ex57	0.51	EUR_HE032 (96%). EUR_HE093 (4%)
ex58	1.83	EUR_HE04549 (93%). EUR_HE043 (6%).EUR_HE055 (1%)
ex62	1.60	EUR_HE043 (75%). EUR_HE0561 (19%). EUR_HE0512 (6%)
ex63	0.07	EUR_HE095 (60%). EUR_HE1232 (27%). EUR_HE0721 (8%). EUR_HE091 (5%)
ex67	3.91	EUR_HE07222
ex70	0.09	EUR_HE0733
ex72	1.01	EUR_HE07221
ex73	2.89	EUR_HE0453
ex75	1.88	EUR_HE07223
ex88	0.04	EUR_HE093

Table A.2 (cont'd)

ex90	4.76	EUR_HE061 (42%). EUR_HE0561 (40%). EUR_HE07221 (6%). EUR_HE07222 (5%). EUR_HE07223 (5%). EUR_HE043 (2%)
ex94	1.4E-06	EUR_HE0453
ex96	0.07	EUR_HE043 (55%). EUR_HE054 (22%). EUR_HE0561 (21%). EUR_HE055 (2%).
ex99	0.05	EUR_HE054 (92%). EUR_HE093 (8%)
ex100	6.1E-05	EUR_HE0453
ex101	0.01	EUR_HE0453
ex103	0.22	EUR_HE055 (97%). EUR_HE043 (3%)
ex104	3.2E-05	EUR_HE0453
ex106	0.03	EUR_HE0561
ex108	0.01	EUR_HE0561
ex114	0.0038	EUR_HE0561
ex116	3.9E-05	EUR_HE0561
ex117	0.03	EUR_HE053
ex118	0.03	EUR_HE053 (75%). EUR_HE121 (11%). EUR_HE0723 (10%). EUR_HE091 (4%)
ex119	0.01	EUR_HE091
ex120	0.06	EUR_HE053 (77%). EUR_HE0724 (23%)
ex121	1.35	EUR_HE08 (76%). EUR_HE091 (17%). EUR_HE0721 (6%). EUR_HE055 (1%)
ex122	0.26	EUR_HE1231 (64%). EUR_HE055 (14%). EUR_HE091 (12%). EUR_HE061 (10%)
ex123	0.01	EUR_HE071 (99.5%). EUR_HE0721 (0.4%). EUR_HE092(0.1%)
ex124	0.02	EUR_HE071 (93%). EUR_HE0721 (3%). EUR_HE0724 (3%). EUR_HE0723 (1%)
ex125	4.83	EUR_HE0511 (64%). EUR_HE1231 (19%). EUR_HE093 (5%). EUR_HE0512 (3%). EUR_HE054 (3%). EUR_HE043 (2%). EUR_HE0561 (2%). EUR_HE0513 (1%). EUR_HE054 (3%). EUR_HE055 (1%) EUR_HE0561 (2%). EUR_HE0513 (1%). EUR_HE054 (3%). EUR_HE055 (1%)
ex128	25.80	EUR_HE0451
ex129	14.28	EUR_HE0451
ex131	0.07	EUR_HE0451
ex133	0.11	EUR_HE0451
ex139	0.09	EUR_HE0451

Table A.2 (cont'd)

ex140	2.61	EUR_HE0451
ex141	17.79	EUR_HE0451
ex147	2.52	EUR_HE0452
ex150	0.16	EUR_HE0453
ex152	2.78	EUR_HE071 (72.6%). EUR_HE0723 (27.2%). EUR_HE0724 (0.2%)
ex153	0.02	EUR_HE07221 (37%). EUR_HE07222 (33%). EUR_HE07223 (29%). EUR_HE07224 (1%)
ex154	0.40	EUR_HE053
ex155	0.21	EUR_HE091 (52%). EUR_HE054 (34%). EUR_HE0513 (8%). EUR_HE053 (6%)
ex156	16.87	EUR_HE111 (89%). EUR_HE112 (8%). EUR_HE096 (3%)
ex157	2.04	EUR_HE0731 (97%). EUR_HE0736 (3%)
ex158	7.00	EUR_HE0732 (99.7%). EUR_HE0724 (0.3%)
ex159	0.03	EUR_HE0452 (79%). EUR_HE0736 (21%)
ex160	0.54	EUR_HE0736 (77%). EUR_HE0734 (23%)
ex161	0.02	EUR_HE0724 (88%). EUR_HE0736 (12%)
ex162	1.52	EUR_HE0733
ex163	0.24	EUR_HE0732 (65%). EUR_HE096 (34.9%). EUR_HE0736 (0.1%)
ex164	8.07	EUR_HE08 (95%). EUR_HE127 (5%)
ex165	6.46	EUR_HE126 (59%). EUR_HE127 (41%)
ex166	0.44	EUR_HE125 (65%). EUR_HE127 (35%)
ex168	57.75	EUR_HE042 (75.9%). EUR_HE041 (24%). EUR_HE044 (0.1%)
ex169	0.51	EUR_HE0562 (67%). EUR_HE0724 (33%)
ex170	0.57	EUR_HE10 (99%). EUR_HE127 (1%)
ex172	0.19	EUR_HE127 (91%). EUR_HE092 (9%)
ex173	0.07	EUR_HE10 (81%). EUR_HE125 (9%). EUR_HE127 (9%)
ex174	0.49	EUR_HE10
ex175	0.00056	EUR_HE121 (51%). EUR_HE062 (34%). EUR_HE063 (13%). EUR_HE127 (2%)
ex179	0.00044	EUR_HE047
ex182	0.0044	EUR_HE050
ex186	0.00024	EUR_HE054
ex188	0.20	EUR_HE056

Table A.2 (cont'd)

ex189	0.22	EUR_HE057
ex190	1.33	EUR_HE058
ex191	0.73	EUR_HE059
ex192	0.01	EUR_HE060
ex193	0.12	EUR_HE061
ex194	0.14	EUR_HE062
ex195	0.07	EUR_HE063
ex196	0.0001	EUR_HE094
ex197	1.13	EUR_HE094 (83%). EUR_HE092 (3%). EUR_HE093 (14%)
ex198	1.67	EUR_HE127 (80%). EUR_HE124 (20%)
ex199	0.01	EUR_HE0562 (52%). EUR_HE124 (48%)

We calculate the indirect emissions of 67 COICOP products by distributing the EXIOBASE emissions in the second column of Table A.2 to the relevant COICOP products according to the ratios in the third column. In the table below, the emissions of similar COICOP products distributed to the same time use activity are given under 34 groups, and their indirect emissions are shown each:

Table A.3. Direct and Indirect Emissions of COICOP Products

COICOP Codes	COICOP Categories	Emissions, in mt
EUR_HE011	Food	52.71
EUR_HE012	Non-alcoholic beverages	7.55
EUR_HE021	Alcoholic beverages	1.34
EUR_HE022	Tobacco	1.19
EUR_HE03	Clothing, footwear	14.78
EUR_HE041	Actual rent	13.86
EUR_HE042	Imputed rent	43.83
EUR_HE043	Maintenance and repair of the dwelling	2.03
EUR_HE044	Water supply and miscellaneous services reacting to the dwelling	2.89
EUR_HE045 (Indirect)	Electricity, gas, liquid fuels, solid fuels, heat energy (Indirect)	71.49

Table A.3 (cont'd)

EUR_HE051	Furniture and furnishings	3.46
EUR_HE052	Household textiles	0.27
EUR_HE053	Household appliances	0.51
EUR_HE054	Glassware, tableware and household utensils	0.30
EUR_HE055	Tools and equipment for house and garden	0.29
EUR_HE056	Goods and services for routine household maintenance	2.75
EUR_HE06	Health	2.01
EUR_HE07 (Indirect)	Mobility (Indirect)	22.05
EUR_HE08	Communication	8.70
EUR_HE091	Audio-visual, photographic and information processing equipment	0.38
EUR_HE092	Other major durables for recreation and culture	0.05
EUR_HE093	Other recreational items and equipment, gardens and pets	0.62
EUR_HE094	Recreational and cultural services	0.94
EUR_HE095	Newspapers, books and stationery	0.04
EUR_HE096	Package holidays	0.57
EUR_HE10	Pre-primary and primary education. Secondary education. Post-secondary education. Tertiary education and Education not defined by level	1.12
EUR_HE111	Catering services	15.01
EUR_HE112	Accommodation services	1.37
EUR_HE121	Personal care	0.004
EUR_HE123	Personal Effects	1.10
EUR_HE124	Social protection	0.34
EUR_HE125	Insurance	0.29
EUR_HE126	Other financial services n.e.c.	3.82
EUR_HE127	Other services n.e.c.	4.71
	Total Indirect	282.37
EUR_HE07 (Direct)	Mobility (Direct)	21.09
EUR_HE045 (Direct)	Electricity, gas and other fuels (Direct)	18.71
	Total Direct	39.80
	Total	322.17

Appendix A.3.

In this study, the COICOP categories and associated time use activities, i.e. the COICOP-Time use concordance matrix, are taken verbatim from Smetschka et al. (2020). The basic assumptions made by Smetschka et al. (2019) while constructing the matrix (the first three entries) and other details are given below:

1. Emissions of basic living expenses such as rent, electricity, water, and fuel (EUR_HE041, EUR_HE042, EUR_HE044, EUR_HE045, EUR_HE051, and EUR_HE052) are allocated to all activities taking place within the house.
2. Contracted time activities are not assigned any consumption goods. Employment is considered when income is earned and allows consumption during non-work time; therefore, no consumption product is assigned to the work time use activity. Food and beverages consumed during working hours are assumed to be provided by the employer; therefore, companies account for these emissions.
3. Tobacco is allocated to all activities except sleep and sport (except Contracted time and mobility).
4. Mobility is attributed to the time use activity "Mobility" (EUR_HE07) category.
5. Emissions from "Communication" (EUR_HE08) and "Insurance and financial services" (EUR_HE125, EUR_HE126, EUR_HE127) are allocated to all activities other than sleep (except contacted time and mobility activities).
6. Emissions from "Food and beverages" (EUR_HE11, EUR_HE12, EUR_HE21) go entirely to eating and drinking.
7. Emissions from "Clothing and footwear" (EUR_HE03), "Personal care" (EUR_HE121), and "Personal effects" (EUR_HE123) are entirely related to personal care time.

8. "Maintenance and repair of the dwelling" (EUR_HE43) and "Tools and equipment for house and garden" (EUR_HE55) are only associated with repairs and gardening.
9. "Health" (EUR_HE06) emissions are allocated to personal care and caring for others.
10. "Social protection" (EUR_HE124) emissions are fully allocated to caring for others.
11. The goods and services for household appliances and maintenance (EUR_HE53, EUR_HE54, and EUR_HE56) are associated with various committed time activities. The category EUR_HE54, which covers expenditure on household utensils like glassware, also goes to eating and drinking.
12. Sub-categories under "Recreation, sport and culture" (EUR_HE09) are allocated to various free time activities.
13. "Educational services" (EUR_HE10) is only assigned to recreational courses and study.
14. All emissions from "Catering services" (EUR_HE111) go to the eating out activity. There are no other consumption products associated with eating out.
15. All emissions from "Accommodation services" (EUR_HE112) go to entertainment and culture.

Appendix A.4.

$$t_j = \frac{261 * \sum_{n=1}^N t_{j,n}^{weekday} * w_n + 104 * \sum_{n=1}^N t_{j,n}^{weekend} * w_n}{\sum_{n=1}^N w_n}$$

where $t_{j,n}^{weekday}$ is the total time spent on activity j, by individual n on a weekday, and $t_{j,n}^{weekend}$ is the total time spent on activity j, by individual n on a weekend day. $\sum_{n=1}^N w_n$ is the total weight of sample, where w_n is the weight of an individual n and N is equal to 25,109, sample size of time-use survey. Yearly occurrence of a weekday is accepted as 261 and weekend day is accepted as 104.

When calculating the daily time of activities according to demographic groups, the same process is carried out based on the relevant sample; in addition, it is divided by 365 to find the daily average.



B. ADDITIONAL RESULTS

Appendix B.1.

To understand whether age matters regarding time use and thus emission caused, we analyse the time use tendencies of people under and over 40. The number of people under 40 is 13,503, while the number of people over 40 is 11,606. People under 40 are referred to as young, and people over 40 are referred to as old.

Table B.1. Daily time-use patterns and emissions, by age

	Total Time (hour:minute)		Total Emission (kg CO ₂ e)	
	Young	Old	Young	Old
Personal Time	11:09	11:09	6.02	6.33
Committed Time	02:21	02:45	0.98	1.19
Contracted Time	03:34	02:20	0.00	0.00
Free Time	05:46	06:46	2.50	2.47
Mobility Time	01:07	00:58	1.59	1.38
Total	24	24	11.09	11.36

Note: The extended table, which includes data for 21 time-use activities, is available in *Appendix C*.

Personal Time: An old person sleeps 11 minutes less, spends 4 minutes less on personal care, and eats 15 minutes more than a young person. Both groups spend 11 hours and 9 minutes on personal time activities. However, since the emission intensity of the eating and drinking category is the highest, the amount of emissions caused by an old person in this category is 0.31 kg CO₂e, more than that of a young person.

Committed Time: In this category, a young person spends 20 minutes more than someone over 40 on caring for others, while an old person spends more time than a young person on the rest of the activities.

On average, an old person spends 23 minutes more per day than a young person on all committed time activities. The amount of emissions caused by these activities is 0.21 kg CO₂e more.

Contracted Time: Young people work 24 minutes more per day on average than older people. Young people spend an average of 50 minutes a day on formal education, compared to 0.6 minutes for the elderly. People over 40 study almost never.

Free Time: Older people spend an average of 1 hour more per day on all free time activities than young people. However, the amount of emissions they cause due to these activities is 0.03 CO₂e less. This means that someone causes less GHG emissions at the same duration by changing their free time habits to less GHG intensive activities.

Young people spend 6 minutes more eating out (1.37 kg/ CO₂e per hour), the most GHG-intensive category. In comparison, older people spend about 50 minutes more volunteering (0.06 kg/ CO₂e per hour), the least GHG-intensive of all activities. Young people spend more time on all activities that keep the body and mind fit, such as sport & outdoor activities, reading, recreational courses & study and hobbies & games.

Mobility: Young people spend an average of 1 hour and 7 minutes daily on transport, compared to 58 minutes for older people. Therefore, young people emit 0.21 kg more emissions per day in transport.

The details of the time allocated to the travelling activity are as follows:

Table B.2. Mobility time according to purpose, by age (hour:minute)

	Under 40	Over 40
Contracted Time	00:34	00:19
Committed Time	00:08	00:11
Free Time	00:16	00:21
Other	00:07	00:06
Total	01:07	00:58

Overall: On average, people over 40 emit 0.27 kg more GHG emissions per day than people under 40. The categories in which older people cause higher emissions are eating & drinking and committed time.

Appendix B.2.

The number of men under the age of 40 is 6,573, men over the age of 40 are 5,577, women under the age of 40 are 6,930, and women over the age of 40 are 6,029.

Table B.3. Daily time-use patterns and emissions, by age and gender

		Men		Women	
		Under 40	Over 40	Under 40	Over 40
Total Time	<i>Personal Time</i>	10:59	10:58	11:19	11:19
(hour:min)	<i>Committed Time</i>	00:39	00:58	04:05	04:26
	<i>Contracted Time</i>	04:57	03:49	02:09	00:56
	<i>Free Time</i>	06:01	06:54	05:31	06:39
	<i>Mobility Time</i>	01:20	01:19	00:53	00:38
Total Emissions (kg CO ₂ e)	<i>Personal Time</i>	5.76	6.14	6.28	6.50
	<i>Committed Time</i>	0.29	0.46	1.68	1.88
	<i>Free Time</i>	2.72	2.70	2.28	2.25
	<i>Mobility Time</i>	1.91	1.87	1.27	0.92
Total		10.68	11.17	11.51	11.55

Note: The extended table, which includes data for 21 time-use activities, is available in *Appendix C*.

Personal Time: Young women spend the most time on sleep (8 hours 55 minutes), while older men spend the least (8 hours 34 minutes). Men spend more time on personal care, with young men spending the most time (52 minutes) and older women spending the least time (42 minutes). Women and older people spend more time on eating & drinking: highest for older women (1 hour 45 min), lowest for younger men (1 hour 16 min).

In total, the average time spent on personal time activities in a day is almost the same for young men and older men (10 hours 59 minutes and 10 hours 58 minutes

respectively) and the same for young women and older women (11 hours 19 minutes). It can be argued that gender rather than age alone is a more important determinant for the personal time category overall.

Although there is a similarity in terms of durations, older men cause more emissions than younger men and older women cause more emissions than younger women. Older women cause the most emissions among the four groups and young men the least. In this category, eating & drinking activity stands out as the biggest reason for the emission differences.

Committed Time: Older men spend the most time on repairs, gardening, shopping, civic matters, and services activities; young women care for others; and older women prepare food, wash dishes, and clean and tidy.

Young men spend the least time on all committed time activities, with an average of 39 minutes per day. Older men spend an average of 58 minutes per day. On the other hand, the total time spent by young and old women for these activities is 4 hours 5 minutes and 4 hours 26 minutes respectively.

While the ratio of emissions from all these activities to daily emissions is 3% and 4% for young and old men, respectively, 15% of the daily emissions of young women and 16% of the daily emissions of old women come from committed time activities.

Contracted Time: Among the four groups, men under 40 work the most, an average of 4 hours and 6 minutes daily. Men over 40 work 18 minutes less than men under 40. For women, this period is 1 hour and 20 minutes for those under 40 and 55 minutes for those over 40. While men under 40 spend 51 minutes and women 49 minutes on formal education, these durations are almost 0 for men and women over 40.

Free Time: Men over 40 spend the most time on all free time activities (6 hours 54 minutes). They are followed by women over the age of 40 (6 hours 39 minutes), while men under the age of 40 spend 6 hours 1 minute, and women under the age of 40 spend 5 hours 31 minutes.

After watching TV, the leisure time activities that women over 40 spend the most time on are volunteering and spending time with family/friends. Women over 40 spend the least time on sports, reading, hobbies & games and eating out.

Men under 40 spend the most time on sports, hobbies & games, and eating out, while women over 40 spend the most time on reading and recreational courses & study. Men and women over 40 spend almost no time on recreational courses & study (45 and 71 seconds, respectively). The two categories that men over 40 spend the most time on are entertainment & culture and watching TV & videos/DVDs, listening to radio & music.

In total, men over 40 spend the most time on free time activities, while men under 40 emit the most emissions (40-men: 2.72, 40+ men: 2.7 kg/ CO₂e). Women over 40 are the second most time-consuming group but the least emitting group (2.25 kg CO₂e). This is because they spend less time on eating out, the activity with the highest GHG emissions, and more time on volunteering, the activity with the lowest GHG intensity. Younger women emit slightly more than women over 40, but the difference is not significant (2.28 kg CO₂e). In general, it can be said that there is a difference in emissions from free time activities due to gender rather than age.

Mobility Time: The time a man spends in transport is almost constant by age (1 hour 20 min and 1 hour 19 min, respectively), while for women, it decreases with age from 53 to 38 minutes.

Table B.4. Mobility time according to purpose, by age and gender (hour:minute)

	Men		Women	
	Under 40	Over 40	Under 40	Over 40
Contracted Time	00:45	00:30	00:23	00:08
Committed Time	00:07	00:12	00:10	00:10
Free Time	00:19	00:28	00:13	00:14
Other	00:09	00:07	00:06	00:05
Total	01:20	01:19	00:53	00:38

In one day, due to mobility, young men emit 1.91 kg CO₂e, older men 1.87 kg CO₂e, young women 1.27 kg CO₂e, and older women 0.92 kg CO₂e.

Overall: Although they cause the least emissions in free time and mobility time activities, due to their high emissions from personal time and committed time activities, the group with the highest total emissions in one day is women over 40 with 11.55 kg CO₂e. In the same categories, women under 40 cause less emissions than women over 40 but more emissions than men, causing a total emission of 11.51 kg CO₂e in one day.

In terms of emissions in young and older men, it may be necessary to pay more attention to free time activities and mobility. The eating out rate is 31 per cent for men under 40 and 23 per cent for men over 40. The group that spends the most time on eating out is women over 40, with an eating out rate of only 11 per cent. For women under 40, this rate is 16 per cent. Such a high eating rate for men under 40, who spend more time on the road and at work, may indicate the problem of time squeeze. Although the amount of emissions from committed time activities is higher for women compared to other groups, there are no significant differences in terms of age. The differences mentioned are primarily due to gender.

C. EXTENDED TABLES

Table C.1. Daily time-use patterns and emissions, by employment status (extended)

	Time-use (in hour)		Emissions (in kg CO ₂ e/d)	
	Employed	Unemployed	Employed	Unemployed
Sleep and rest	8.04	9.05	2.35	2.65
Personal Care	0.84	0.79	0.90	0.86
Eating & Drinking	1.11	1.78	1.94	3.11
Repairs & Gardening	0.05	0.15	0.05	0.17
Food Preparation & Dish Washing	0.32	1.55	0.13	0.65
Caring for others	0.21	0.63	0.09	0.27
Cleaning, tidying	0.18	1.06	0.08	0.44
Shopping, Civic Matters & Services	0.15	0.27	0.01	0.02
work (excluded)	7.55	0.28	0.00	0.00
study (excluded)	0.02	0.38	0.00	0.00
Entertainment & Culture	0.60	1.03	0.27	0.46
Pet care	0.02	0.09	0.01	0.03
Sport & Outdoor Activities	0.10	0.19	0.01	0.02
Spending time with family/friends	0.66	1.44	0.24	0.51
Reading	0.09	0.18	0.03	0.06
Recreational courses & study	0.03	0.26	0.02	0.13
Hobbies & Games	0.10	0.18	0.04	0.08
Watching TV & Videos/DVDs. Listening to Radio & Music	1.52	2.50	0.54	0.89
Eating out	0.69	0.27	0.95	0.37
Volunteering	0.32	1.02	0.02	0.06
Mobility	1.42	0.89	2.01	1.26
Total	24.00	24.00	9.69	12.06

Table C.2. Daily time-use patterns and emissions, by employment status & gender (extended)

	Time-use (in hour)				Emissions (in kg CO ₂ e/d)			
	11	21	12	22	11	21	12	22
Sleep and rest	8.01	9.32	8.12	8.91	2.35	2.38	2.73	2.61
Personal Care	0.83	0.90	0.85	0.74	0.90	0.93	0.98	0.80
Eating & Drinking	1.12	1.70	1.09	1.82	1.95	1.91	2.97	3.19
Repairs & Gardening	0.05	0.25	0.02	0.10	0.06	0.02	0.28	0.11
Food Preparation & Dish Washing	0.10	0.22	1.06	2.25	0.04	0.45	0.09	0.95
Caring for others	0.17	0.21	0.32	0.86	0.07	0.14	0.09	0.37
Cleaning, tidying	0.06	0.18	0.59	1.53	0.02	0.25	0.08	0.64
Shopping, Civic Matters & Services	0.14	0.32	0.17	0.25	0.01	0.01	0.02	0.02
work (excluded)	7.74	0.47	6.93	0.18	0.00	0.00	0.00	0.00
study (excluded)	0.02	0.56	0.03	0.29	0.00	0.00	0.00	0.00
Entertainment & Culture	0.63	1.28	0.49	0.90	0.28	0.22	0.57	0.40
Pet care	0.02	0.13	0.02	0.07	0.01	0.01	0.05	0.03
Sport & Outdoor Activities	0.11	0.38	0.06	0.10	0.01	0.01	0.04	0.01
Spending time with family/friends	0.68	1.61	0.60	1.35	0.24	0.21	0.57	0.48
Reading	0.08	0.23	0.13	0.15	0.03	0.05	0.08	0.05
Recreational courses & study	0.02	0.30	0.06	0.24	0.01	0.03	0.15	0.12
Hobbies & Games	0.12	0.41	0.03	0.05	0.05	0.02	0.18	0.02
Watching TV & Videos/DVDs, Listening to Radio & Music	1.60	2.92	1.23	2.28	0.57	0.44	1.04	0.81
Eating out	0.72	0.37	0.61	0.22	0.98	0.84	0.51	0.30
Volunteering	0.32	0.97	0.30	1.04	0.02	0.02	0.06	0.06
Mobility	1.46	1.27	1.27	0.69	2.07	1.80	1.81	0.97
Total	24.00	24.00	24.00	24.00	9.68	9.71	12.29	11.93

Note: 11: Employed men, 21: Unemployed men, 12: Employed women, 22: Unemployed women

Table C.3. Daily time-use patterns and emissions, by married employed men & married employed women (extended)

	Time-use (in hour)		Emissions (in kg CO ₂ e/d)	
	Married Employed Men	Married Employed Women	Married Employed Men	Married Employed Women
Sleep and rest	7.93	7.94	2.32	2.32
Personal Care	0.82	0.79	0.88	0.86
Eating & Drinking	1.19	1.14	2.08	2.00
Repairs & Gardening	0.06	0.02	0.07	0.03
Food Preparation & Dish Washing	0.09	1.43	0.04	0.60
Caring for others	0.23	0.47	0.10	0.20
Cleaning, tidying	0.05	0.78	0.02	0.33
Shopping, Civic Matters & Services	0.16	0.17	0.01	0.01
work (excluded)	7.72	6.74	0.00	0.00
study (excluded)	0.01	0.01	0.00	0.00
Entertainment & Culture	0.58	0.44	0.26	0.20
Pet care	0.02	0.02	0.01	0.01
Sport & Outdoor Activities	0.08	0.05	0.01	0.00
Spending time with family/friends	0.66	0.62	0.24	0.22
Reading	0.08	0.09	0.03	0.03
Recreational courses & study	0.01	0.01	0.01	0.01
Hobbies & Games	0.09	0.02	0.04	0.01
Watching TV & Videos/DVDs, Listening to Radio & Music	1.69	1.18	0.60	0.42
Eating out	0.68	0.55	0.94	0.76
Volunteering	0.40	0.34	0.02	0.02
Mobility	1.45	1.18	2.06	1.67
Total	24	24	9.72	9.69

Table C.4. Daily time-use patterns and emissions, by marital status (extended)

	Time-use (in hour)		Emissions (in kg CO ₂ e/d)	
	Single	Married	Single	Married
Sleep and rest	9.28	8.46	2.72	2.48
Personal Care	0.89	0.76	0.96	0.83
Eating & Drinking	1.41	1.63	2.47	2.85
Repairs & Gardening	0.07	0.13	0.08	0.15
Food Preparation & Dish Washing	0.62	1.33	0.26	0.56
Caring for others	0.21	0.66	0.09	0.29
Cleaning, tidying	0.43	0.90	0.18	0.38
Shopping, Civic Matters & Services	0.16	0.26	0.01	0.02
work (excluded)	2.00	2.96	0.00	0.00
study (excluded)	1.14	0.02	0.00	0.00
Entertainment & Culture	0.96	0.79	0.43	0.35
Pet care	0.05	0.07	0.02	0.03
Sport & Outdoor Activities	0.28	0.13	0.03	0.01
Spending time with family/friends	1.03	1.18	0.37	0.42
Reading	0.25	0.11	0.09	0.04
Recreational courses & study	0.64	0.03	0.32	0.01
Hobbies & Games	0.39	0.09	0.17	0.04
Watching TV & Videos/DVD, Listening to Radio & Music	2.18	2.17	0.78	0.77
Eating out	0.41	0.40	0.56	0.55
Volunteering	0.53	0.86	0.03	0.05
Mobility	1.06	1.06	1.50	1.50
Total	24	24	11.07	11.31

Table C.5. Daily time-use patterns and emissions, by marital status & gender (extended)

	Time-use (in hours)				Emissions (in kg CO ₂ e/d)			
	11	21	12	22	11	21	12	22
Sleep and rest	9.18	8.41	9.38	8.51	2.69	2.46	2.74	2.49
Personal Care	0.88	0.85	0.90	0.68	0.96	0.92	0.97	0.74
Eating & Drinking	1.30	1.45	1.53	1.80	2.27	2.54	2.67	3.14
Repairs & Gardening	0.09	0.17	0.06	0.10	0.10	0.19	0.06	0.11
Food Preparation & Dish Washing	0.16	0.12	1.09	2.50	0.07	0.05	0.46	1.05
Caring for others	0.12	0.25	0.29	1.07	0.05	0.11	0.12	0.46
Cleaning, tidying	0.11	0.11	0.75	1.66	0.04	0.05	0.31	0.70
Shopping, Civic Matters & Services	0.13	0.26	0.18	0.25	0.01	0.02	0.01	0.02
work (excluded)	2.85	4.82	1.15	1.16	0.00	0.00	0.00	0.00
study (excluded)	1.17	0.01	1.10	0.03	0.00	0.00	0.00	0.00
Entertainment & Culture	0.99	0.85	0.94	0.73	0.44	0.38	0.42	0.33
Pet care	0.07	0.07	0.03	0.07	0.03	0.03	0.01	0.03
Sport & Outdoor Activities	0.43	0.18	0.13	0.08	0.05	0.02	0.01	0.01
Spending time with family/friends	1.00	1.09	1.07	1.26	0.36	0.39	0.38	0.45
Reading	0.20	0.14	0.29	0.09	0.07	0.05	0.10	0.03
Recreational courses & study	0.57	0.02	0.70	0.04	0.29	0.01	0.35	0.02
Hobbies & Games	0.56	0.16	0.23	0.03	0.24	0.07	0.10	0.01
Watching TV & Videos/DVDs, Listening to Radio & Music	2.11	2.31	2.26	2.03	0.75	0.82	0.80	0.72
Eating out	0.49	0.55	0.32	0.25	0.68	0.76	0.43	0.34
Volunteering	0.33	0.77	0.74	0.94	0.02	0.05	0.04	0.06
Mobility	1.25	1.40	0.87	0.73	1.77	1.99	1.23	1.03
Total	24	24	24	24	10.88	10.89	11.25	11.72

Note: 11: Single Men, 21: Married Men, 12: Single Women, 22: Married Women

Table C.6. Daily time-use patterns and emissions, by age (extended)

	Time-use (in hour)		Emissions (in kg CO ₂ e/d)	
	Under 40	Over 40	Under 40	Over 40
Sleep and rest	8.88	8.70	2.60	2.55
Personal Care	0.85	0.78	0.92	0.84
Eating & Drinking	1.43	1.68	2.50	2.94
Repairs & Gardening	0.06	0.17	0.07	0.19
Food Preparation & Dish Washing	0.89	1.23	0.37	0.52
Caring for others	0.62	0.28	0.27	0.12
Cleaning, tidying	0.61	0.82	0.25	0.35
Shopping, Civic Matters & Services	0.19	0.26	0.01	0.02
work (excluded)	2.73	2.32	0.00	0.00
study (excluded)	0.84	0.01	0.00	0.00
Entertainment & Culture	0.77	0.99	0.34	0.44
Pet care	0.05	0.08	0.02	0.03
Sport & Outdoor Activities	0.22	0.16	0.02	0.02
Spending time with family/friends	0.99	1.29	0.35	0.46
Reading	0.19	0.13	0.07	0.05
Recreational courses & study	0.48	0.02	0.24	0.01
Hobbies & Games	0.30	0.10	0.13	0.05
Watching TV & Videos/DVDs, Listening to Radio & Music	1.95	2.48	0.69	0.88
Eating out	0.44	0.35	0.61	0.47
Volunteering	0.37	1.19	0.02	0.07
Mobility	1.12	0.97	1.59	1.38
Total	24	24	11.09	11.36

Table C.7. Daily time-use patterns and emissions, by age & gender (extended)

	Time-use (in hour)				Emissions (in kg CO ₂ e/d)			
	11	21	12	22	11	21	12	22
Sleep and rest	8.85	8.92	8.58	8.81	2.59	2.51	2.61	2.58
Personal Care	0.87	0.82	0.85	0.71	0.95	0.92	0.88	0.77
Eating & Drinking	1.27	1.59	1.55	1.80	2.23	2.71	2.78	3.15
Repairs & Gardening	0.09	0.04	0.20	0.13	0.10	0.23	0.05	0.15
Food Preparation & Dish Washing	0.11	1.69	0.19	2.21	0.04	0.08	0.71	0.93
Caring for others	0.23	1.01	0.15	0.40	0.10	0.07	0.44	0.17
Cleaning, tidying	0.08	1.14	0.15	1.46	0.03	0.06	0.48	0.61
Shopping, Civic Matters & Services	0.16	0.21	0.28	0.24	0.01	0.02	0.01	0.02
work (excluded)	4.10	1.33	3.81	0.92	0.00	0.00	0.00	0.00
study (excluded)	0.86	0.83	0.01	0.01	0.00	0.00	0.00	0.00
Entertainment & Culture	0.85	0.69	0.99	0.98	0.38	0.44	0.31	0.44
Pet care	0.07	0.03	0.07	0.09	0.03	0.03	0.01	0.03
Sport & Outdoor Activities	0.33	0.11	0.22	0.10	0.04	0.02	0.01	0.01
Spending time with family/friends	0.95	1.04	1.21	1.36	0.34	0.43	0.37	0.48
Reading	0.16	0.23	0.18	0.10	0.06	0.06	0.08	0.03
Recreational courses & study	0.43	0.54	0.01	0.02	0.21	0.01	0.27	0.01
Hobbies & Games	0.43	0.17	0.18	0.03	0.19	0.08	0.08	0.01
Watching TV & Videos/DVDs, Listening to Radio & Music	1.95	1.95	2.60	2.36	0.69	0.92	0.69	0.84
Eating out	0.57	0.31	0.47	0.23	0.78	0.65	0.43	0.31
Volunteering	0.30	0.44	0.98	1.40	0.02	0.06	0.03	0.08
Mobility	1.35	0.89	1.32	0.65	1.91	1.87	1.27	0.92
Total	24	24	24	24	10.68	11.17	11.51	11.55

Note: 11: Men under 40, 21: Men over 40, 12: Women under 40, 22: Women over 40

D. TURKISH SUMMARY / TRKE ZET

Giriř

2015 Birleřmiř Milletler İklim Deęiřiklięi Konferansı'nda 193 lke tarafından imzalanan ve 2016 yılında yrrlęe giren Paris Anlařması'nın temel hedefi; kresel ortalama sıcaklıęın uzun dnem ortalamaya kıyasla artıřını 2 derecenin altında tutmaktır. Bu erevede katılımcı lkelerin sera gazı emisyonlarını azaltmalarını, srdrlebilir kalkınmayı teřvik etmelerini, temiz enerji teknolojilerini geliřtirmelerini ve iklim deęiřiklięinin olumsuz etkilerine uyum saęlamalarını ngrlmektedir.

Trkiye de iklim deęiřiklięiyle mcadele ve uyum abalarının bir parası olarak 2016 yılında Paris Anlařması'nı imzalamıřtır. Anlařma 2021 yılında meclisten gemiřtir. Aynı yıl Avrupa Yeřil Mutabakatıyla paralel olarak hazırlanan Yeřil Mutabakat Eylem Planı yayınlamıřtır. Ayrıca Trkiye 2053 yılına kadar net sıfır olmayı hedeflemektedir. Trkiye'de son yıllarda bu geliřmelerle beraber iklim politikalarının kararlařtırılması ve uygulanması hız kazanmıřtır.

Uluslararası literatrde karbon ayak izinin azaltılmasına ynelik politikalar arasında karbon vergisi ve emisyon ticaret sistemleri etkin ve etkili yntemler olarak ne ıkmıřtır. Bu yntemlerin bařarısı her ne kadar eřitli alıřmalarla (Andersson, 2019; Colmer vd., 2020) gsterilmiř olsa da kresel ısınmanın nlenmesi iin kat edilmesi gereken daha fazla mesafe olduęu ortadadır (United Nations, 2023). Hem daha yaratıcı politikalar geliřtirmek hem de geliřtirilen politikaların sosyoekonomik etkilerini deęerlendirmek amacıyla uluslararası literatrde mikroekonomik alıřmalar son zamanlarda hız kazanmıřtır. Bu alıřmalarla temelde firmaların ve hanehalklarının karbon ayak izine heterojen katkılarını lmek amalanmaktadır. Bu sayede hem mikro temelli politikalar daha saęlıklı belirlenebilir hem de var olan ve uygulanması

planlanan politikaların çeşitli toplum grupları (gelir, eğitim, yaş vb. sınıflar) üzerine etkisi incelenebilir.

2015 yılı için yapılan hesaplamalarda, Türkiye'deki toplam 549 milyon ton CO₂e talep çeşitli emisyonun 322 milyon tonundan, yani yüzde 59'undan, hanehalkları sorumludur. (EXIOBASE). Bu sebeple karbon ayak izi azaltma faaliyetlerinde hanehalkları da dikkate alınmalıdır. Hanehalkları üzerine çevresel iktisat alanında yapılan mikro çalışmalarda iki temel yöntem göze çarpmaktadır. Bunlardan ilki hanehalkı tüketim anketleri üzerinden, hanelerin yaptıkları harcamalara karşılık gelen karbon ayak izinin hesaplanmasıdır. Örnek olarak Wang vd. (2016), Ivanova ve Wood (2020), Theine vd. (2022) ve Sri vd. (2023) çalışmaları gösterilebilir.

İkinci yöntem ise bireylerin tüketim davranışları ile zaman kullanımlarının ilişkilendirilmesi ve böylece gün içerisinde yapılan aktivitelerin karbon ayak izinin hesaplanmasıdır (örn., Druckman vd., 2012; Smetschka vd., 2019; Yu vd., 2019; Jiang vd., 2023). Literatürdeki talep taraflı çalışmaların çoğu, hanehalklarının paralarını nasıl harcadıkları ile bu harcamaların yol açtığı sera gazı emisyonları arasındaki ilişkiyi incelerken; bireylerin zaman kullanım alışkanlıklarının sera gazı üzerindeki etkileri ikinci planda kalmıştır (Druckman vd., 2012). Bireylerin tüketim davranışları, gelirlerinin yanı sıra zaman kullanım alışkanlıklarından da büyük ölçüde etkilenmektedir. Örneğin, bir birey boş zamanlarını kitap okuyarak veya parkta yürüyerek geçirirken, bir diğeri bir restoranda sosyalleşmeyi tercih edebilir. Bu tercihleri nedeniyle harcamaları ve karbon ayak izleri farklı olacaktır. Ayrıca, gelir herkes için farklılık gösterse de herkes günde aynı 24 saate sahiptir. Zaman kullanım analizi, karbon ayak izini azaltmak için daha az tüket perspektifinden; daha sürdürülebilir ve keyifli faaliyetlere zaman ayırarak daha az karbon ayak izine sahip ol perspektifine geçişe olanak sağlar (Smetschka vd., 2019).

Bu çalışmada, uluslararası literatürün gelişimine uygun olarak, karbon ayak izi azaltma faaliyetleri kapsamında talep taraflı öneriler sunmak ve çeşitli yaşam tarzlarının çevresel etkilerini anlamak amacıyla, Türkiye'deki bireylerin zaman kullanım alışkanlıklarını incelenecek; günlük aktivitelerin sebep olduğu emisyon miktarı ve karbon yoğunlukları hesaplanacaktır.

Çevresel olarak genişletilmiş girdi-çıkı tablosu EXIOBASE ile TÜİK Zaman Kullanım Araştırmasının, TÜİK Hanehalkı Bütçe Anketi ve çeşitli dönüşüm matrisleri yardımıyla bir arada kullanmaya uygun hale getirilmesinin ardından; zaman kullanım aktivitelerinin saat başına sera gazı (GHG) emisyon yoğunluğu tahmin edilecektir. Zaman kullanım anketinde yer alan cinsiyet, çalışma durumu, medeni hal ve yaş gibi demografik kırılımlara göre bireylerin zaman kullanım eğilimleri ve bunların çevresel etkileri incelenecektir.

Çalışmanın temel bulguları yeme-içme aktivitesinin görece daha fazla GHG-yoğun olduğu, cinsiyete dayalı iş bölümünün kadın ve erkeklerin zaman kullanım alışkanlıklarını ve dolayısıyla karbon ayak izlerini şekillendirdiği olmuştur. Cinsiyetin yanı sıra; çalışan ve çalışmayan, evli ve bekar gruplarının arasında da zaman kullanım alışkanlıkları ve dolayısıyla sebep olunan günlük emisyon arasında belirgin farklar gözlemlenmiştir. Çalışmanın bir diğer bulgusu da Türkiye’de saat başına ortalama karbon yoğunluğunun literatürdeki çalışmaların sonuçlarına göre gelişmiş ülkelere göre çok daha düşük olduğudur.

Elde edilen bu sonuçlara göre; 4 temel politika önerilerimiz bulunmaktadır. Bunlardan ilki yeme-içme kategorisinin karbon yoğunluğunun azaltılması ile ilgilidir. Diğerleri ise; çalışan grubu (özellikle çalışan erkekler), kadınları (özellikle çalışmayan kadınları) ve çalışmayanları (özellikle çalışmayan erkekleri) hedef almaktadır.

Arka Plan ve Literatür Taraması

İklim değişikliği ile mücadele kapsamında şimdiye dek uygulanan ve genel olarak üretim odaklı politikalar (karbon vergisi, emisyon ticaret sistemi vs.) sera gazı emisyonlarının azaltılması için önemli fırsatlar sunsa da küresel ısınmanın önlenmesi için kat edilmesi gereken daha fazla mesafe olduğu ortadadır (United Nations, 2023). Bu bağlamda, çevresel iktisat literatüründe mikroekonomik verilerle desteklenen, tüketim odaklı çalışmaların önemi artmaktadır. Bu çalışmalar, tüketicilerin tercihleri ve davranışlarının ürünlerin üretiminden tüketimine kadar olan süreçte kritik bir rol oynadığını vurgular; bireylerin ve hanehalklarının karbon ayak izlerini anlamalarına ve azaltmaları yönünde doğru politikalar önerilmesine zemin hazırlar.

Literatürde tüketici alışkanlıkları ve karbon ayak izi arasındaki ilişkiyi incelemek için iki temel yöntem öne çıkmaktadır: Bunlardan birincisi ve daha yaygın olanı, hanehalkı tüketim anketleri üzerinden hanehalkı tüketim harcamasına karşılık gelen karbon ayak izinin hesaplanmasıdır (Druckman ve Jackson, 2009; Girod ve de Haan, 2009; Wang vd., 2016; Mi vd., 2019; Ivanova ve Wood, 2020)

İkinci yöntem ise bireylerin tüketim davranışları ile zaman kullanımlarının ilişkilendirilmesi ve böylece gün içerisinde yapılan aktivitelerin karbon yoğunluğunun hesaplanmasıdır. Bu çalışmalarda tüketim davranışının zaman kullanım alışkanlıkları tarafından etkilendiği vurgulanmaktadır.

Schipper vd.'nin 1989 yılında gerçekleştirdiği araştırma, literatürde zaman kullanımı ve enerji tüketimi arasındaki ilişkiyi ele alan öncü çalışmalardan biri olarak kabul edilmektedir. Bu çalışma, Amerika Birleşik Devletleri'nde bireylerin yaşam tarzları ve tüketici aktivitelerinin enerji kullanımı üzerindeki etkilerini kapsamlı bir şekilde analiz etmektedir. Çalışmanın temel hedefi, davranışsal değişikliklerin geçmişten günümüze enerji kullanımını nasıl şekillendirdiğini ortaya koymak ve bireysel ile toplumsal aktivitelerdeki muhtemel evrimin gelecekteki enerji talebini anlamak için kritik olduğunu vurgulamaktır. Özellikle, seyahatle ilgili aktivitelerin, evde veya hizmet binalarında gerçekleşen aktivitelere kıyasla daha fazla enerji yoğun olduğu tespit edilmiş; toplumun gelecekteki mobilite derecesinin enerji talebi üzerinde belirleyici olacağı sonucuna ulaşılmıştır.

Gelecek yıllarda farklı ülkeler için de zaman kullanımı ve enerji kullanımının incelendiği çalışmalar çeşitlenmiştir. Bunlara örnek olarak; Finlandiya (Jalas, 2002; Jalas, 2005; Jalas ve Juntunen, 2015), Kanada (Brenčić ve Young, 2009), Norveç (Aall, 2011) ve Fransa (De Lauretis vd., 2017) çalışmaları örnek verilebilir. Zaman kullanımı ve enerji tüketimi üzerine derin bir anlayış kazanmamızı sağlayan bu çalışmalar, görece daha az çalışılmış zaman kullanımı ve emisyon ilişkisinin incelendiği diğer çalışmalara öncü olmuştur. Literatürde sistemik bir biçimde zaman kullanım aktivitelerine dayalı emisyon tahminleri yapan dört çalışma mevcuttur: Birleşik Krallık (Druckman vd., 2012), Avusturya (Smetschka vd., 2019), Çin (Yu vd., 2019) ve Japonya (Jiang vd., 2021).

Druckman vd. (2012) Birleşik Krallık için çevresel hesaplar (2008 *UK Environmental Accounts*), çevresel olarak genişletilmiş girdi-çıktı tablosu (EEIO-SELMA) ve zaman kullanım anketini (2006); çeşitli dönüşüm tablolarıyla harmanlayarak zaman kullanım aktivitelerinin birim zaman başına sera gazı emisyonunu hesaplamıştır. Ücretli ve gönüllü çalışma saatleri, resmi eğitim süreleri ve tatil günleri dışarıda bırakılarak, yalnızca iş dışı aktiviteler ve bu aktivitelerin çevresel emisyonlarına odaklanılmış; günlük zamanın %86'sı, toplamda 18 farklı zaman kullanım kategorisinde incelenmiştir. Elde edilen bulgular, karbon ayak izlerinde görülen cinsiyet farklılıklarını belirginleştirmekte; kadınların, erkeklere kıyasla daha düşük karbon emisyonu gerektiren boş zaman etkinliklerine daha az zaman ayırıp, ev işlerine daha fazla zaman harcamalarından ötürü daha yüksek emisyon değerlerine sahip olduklarını ortaya koymaktadır.

Smetschka vd. (2019) Avusturya zaman kullanım anketi (2008-2009), hanehalkı bütçe anketi (2010) ve çok bölgeli girdi-çıktı modeli (EORA-MRIO) kullanarak Avusturya hanehalkı günlük aktivitelerinin karbon ayak izi yoğunluğunu hesaplamıştır. 427 zaman kullanım aktivitesi 83'e indirgenerek 63'ü mobilite aktivitelerine, geri kalan 20'si ise 4 fonksiyonel zaman kullanım aktivitesine dağıtılmıştır: kişisel zaman (uyku, kişisel bakım, yeme ve içme vb.), adanmış zaman (temizlik, başkaları için bakım, yemek hazırlığı, tamir vb.), sözleşmeli zaman (iş ve eğitim) ve boş zaman (eğlence ve kültür, televizyon izleme, gönüllü aktiviteler vb.). Her bir harcama kategorisi (COICOP), bir veya daha fazla zaman kullanım aktivitesine dağıtılarak bir zaman-tüketim dönüşüm matrisi elde edilmiş ve böylece her bir aktivitenin saat başına ortalama karbon yoğunluğu tahmin edilmiştir. Çalışmanın temel bulguları kişisel zamanın görece daha az karbon-yoğun olduğu, geleneksel cinsiyete dayalı iş bölümünün kadın ve erkeklerin zaman kullanım desenlerini ve dolayısıyla karbon ayak izlerini şekillendirdiği olmuştur. Bunların yanısıra hane büyüklüğü, gelir, konum ve altyapı ulaşılabilirliği karbon ayak izini etkileyen diğer faktörler arasındadır.

Yu vd. (2019), çalışmalarında Çin zaman kullanım anketi (2008), hanehalkı tüketim verisi (2009), hanehalkı direkt enerji tüketim verisini (2009) kullanarak; girdi-çıktı analiz yöntemiyle, enerji ve emisyon problemini sonlu zaman kullanım problemine dönüştürmeye çabalamıştır. Diğer çalışmalardan farklı olarak sadece Çin değil, ilgili

lkeler iin benzer veri setleri kullanılarak analiz altı geliřmiř lkeyi de (Japonya, Avusturya, Almanya, Finlandiya, Birleřik Krallık ve Amerika Birleřik Devletleri) dahil ederek geniřletilmiřtir. 14 zaman kullanım aktivitesinin karbon yoęunluęu hesaplanmıř ve aktiviteler; uzun sreli ve dřk karbon yoęun (uyku ve dinlenme, rekreasyon ve boř zaman, yeme ve ime, seyahat vb.), kısa sreli ve yksek karbon yoęun (tamirat, bahe iřleri ve evcil hayvan bakımı vb.), kısa sreli ve dřk karbon yoęun (eęlence ve kltr, spor ve dıřarı aktiviteleri vb.), uzun sreli ve yksek karbon yoęun (yemek hazırlıęı ve bulařık yıkama, kiřisel bakım vb.) olarak sınıflandırılmıřtır. alıřmada blgesel ve lkeler arası farklılıklar incelenmiř; rneęin seyahat aktivitesinin karbon yoęunluęunun ABD'de daha yksek, Japonya'da daha dřk olduęu grlmřtir. Bu da karbon ayak izi azaltma alıřmalarında doęru ıkarım ve etkili politika nerilerinde bulunabilmek iin her lkenin kendi zelinde deęerlendirilmesi ve farklı lkeler iin benzer alıřmaların artması gerektięinin bir gstergesidir.

Karbon ayak izi azaltma alıřmalarına zaman kullanımı perspektifinden yaklařan en gncel ve gnlk aktivite sayısı bakımından (85 kategori) en kapsamlı alıřma Japonya iin Jiang vd. (2022) tarafından yapılmıřtır. nceki alıřmalara benzer olarak hanehalkı bte anketi (NSFIE, 2004), zaman kullanım ve boř zaman aktiviteleri anketi (STULA, 2006) ve evresel olarak geniřletilmiř girdi-ıktı tablosu kullanılmıřtır. İki adımlı analizin birinci adımımda hanehalkı bte anketi ve girdi-ıktı tablosunun kullanılarak tketim rnlerinin direkt ve dolaylı emisyonları hesaplanmıřtır. İkinici adımda ise tketim rnleri zaman kullanım aktiviteleriyle eřleřtirilerek ilk adımda hesaplanan tketim rnlerinin emisyonu aktivitelere daęıtılmıř ve aktivitelerin emisyon yoęunluęu hesaplanmıřtır. Bu alıřmalar, zaman kullanımı ve enerji tketimi arasındaki iliřkiyi derinlemesine anlamamızı saęlayarak, bu alanda daha az incelenmiř zaman kullanımı ve emisyon iliřkisini keřfetmemize yardımcı olmuřtur.

Veri ve Yntem

Bu alıřmada temel olarak  veri seti kullanılmıřtır: EXIOBASE (2015), TİK Zaman Kullanım Anketi (2014/2015) ve TİK Hanehalkı Bte Anketi (2015).

EXIOBASE (Stadler vd., 2021), bir çevresel olarak genişletilmiş çok bölgeli girdi-çıktı veri tabanıdır (EE-MRIO). Açık kaynak olarak sunulan bu veri tabanı, 200 farklı üründen kaynaklanan çevresel etkiyi, yani doğrudan ve dolaylı emisyonları ölçen çeşitli metrikleri içermektedir. Emisyon katsayıları, herhangi bir ürün için yapılan bir milyon Euro'luk harcama ile salınan CO₂, CH₄, N₂O ve SF₆'nın kg CO₂ eşdeğerini (CO₂e) temsil etmektedir.

Türkiye için 2015 yılı doğrudan ve dolaylı emisyon miktarı EXIOBASE v3.8.2'den alınmıştır. EXIOBASE verisine göre Türkiye'de toplam talep çekişli emisyon miktarı yaklaşık 549 mt CO₂ eşdeğeridir. TÜİK verilerine göre 2015 toplam sera gazı emisyonu 475 mt CO₂ eşdeğeri olarak hesaplanmıştır. Bu değer üretim verileri baz alınarak hesaplanırken EXIOBASE tüketim kaynaklı emisyonu hesaplamaktadır. Bundan dolayı, Türkiye'ye atfedilen 548 mt CO₂ eşdeğer emisyon miktarı ithal malların emisyonunu da kapsamaktadır. Cari açıktan kaynaklanan negatif emisyon miktarı (ihracat-ithalat), EXIOBASE verisinden hesapladığımız 548 mt CO₂ emisyonu düşürerek bizi 478 mt CO₂ emisyonu yaklaştıracaktır. Böylece EXIOBASE emisyon verilerinin gerçek verilerle tutarlı olduğunu ve ek bir ölçeklendirme işlemine gerek kalmadığını teyit etmekteyiz.

EXIOBASE emisyonlarını zaman kullanım aktivitelerine atfetmek için iki adımlı hesaplama yaptık. İlk olarak 200 EXIOBASE ürününün emisyonları 67 COICOP ürününe, ardından 67 COICOP ürününün emisyonları 21 zaman kullanım aktivitesine dağıtıldı.

EXIOBASE veri setinin sınıflandırması ürünlerin belli bir zaman kullanım aktivitelerine atfedilmesi için uygun değildir (örneğin; EX20: "Anthracite", EX32: "Uranium and thorium ores (12)"). Öte yandan COICOP (*The Classification of Individual Consumption According to Purpose*) uluslararası olarak kabul gören bir hanehalkı harcamaları sınıflandırmasıdır. Druckman vd. (2012) ve Smetschka vd. (2019) çalışmalarında tüketim ürünleri ve zaman kullanım aktiviteleri arasındaki dağılımı yaparken COICOP sınıflandırmasını kullanmışlardır. Bu gerekçelerle, ilk olarak EXIOBASE ürünleri ve COICOP ürünleri arasında bir dönüşüm tablosu oluşturduk.

Ivanova ve Wood (2020) 63 COICOP kategorisinin 200 EXIOBASE kategorisine dağıtıldığı bir uyumluluk tablosu (63x200) oluşturmuştur. Bu tabloyu Gürer vd. (2024) Türkiye özelinde modifiye ederek 67x200'lük bir matris elde etmiştir. Biz de bu çalışmada Gürer vd.'nin (2024) tablosundaki oranları 2015 TÜİK Hanehalkı Bütçe Anketindeki tüketim harcamalarına göre ağırlıklandırarak EXIOBASE-COICOP uyumluluk matrisi (200x67) elde ettik. Ardından oluşturduğumuz EXIOBASE-COICOP uyumluluk matrisi yardımıyla 200 EXIOBASE ürününün dolaylı emisyonlarını 67 COICOP kategorisine dağıttık.

Doğrudan emisyonlar ise ulusal hesaplardan elde edildiğinden tüketim harcamalarına göre ayrıştırılmamıştır. EXIOBASE verilerine göre hanehalklarının sebep olduğu toplam 39.80 mt CO₂e emisyonun %53'ü mobilite, %47'si ise elektrik, gaz ve diğer yakıtlar kategorisine dağıttık (Gürer vd., 2024). Doğrudan emisyonların da belirtilen COICOP kategorilerine eklenmesiyle, 67 COICOP ürününün toplam emisyonu hesapladık.

İkinci aşamada, Smetschka vd.'nin (2019) tüketim ürünleriyle zaman kullanım aktivitelerini eşlediği COICOP-Aktivite uyumluluk matrisi (67x21) kullanılmıştır. Bu matris yardımıyla bir önceki aşamada hesapladığımız 67 COICOP ürününün emisyonları 21 zaman kullanım aktivitesine, aktivitelerin görece uzunluğuyla orantılı şekilde olacak şekilde dağıtılmıştır.

Son adımda ise, aktivitelerin toplam emisyonu toplam uzunluğuna bölerek aktivitelerin saat başına sera gazı emisyon yoğunluğunu hesapladık.

Bulgular

Türkiye'de saat başına ortalama GHG emisyon yoğunluğu 0,47 kg CO₂e olarak bulunmuştur. Yeme-içme, mobilite, dışarıda yemek yeme, onarım-bahçe işleri ve kişisel bakım sırasıyla saat başına en yüksek GHG emisyon yoğunluğuna sahip faaliyetlerdir. Evcil hayvan bakımı, aile/arkadaşlarla vakit geçirme, okuma, spor-açık hava etkinlikleri ve gönüllülük gibi boş zaman etkinlikleri düşük GHG emisyon yoğunluğuna sahip faaliyetler arasındadır.

İşlevsel zaman kullanımı (FTU) faaliyetleriyle ilişkin olarak, saat başına en yüksek GHG emisyon yoğunluğu 1,42 kg CO₂e ile mobilite kategorisindedir. Mobilite zamanı (*mobility*) günlük zamanın sadece yüzde 4'ünü alırken, neden olduğu emisyonlar yüzde 13'ünü oluşturmaktadır. İkinci sırada 0,55 kg CO₂e ile kişisel zaman (*personal time*) yer alırken, bunu 0,42 kg CO₂e ile ev işlerine ayrılan zaman (*committed time*) takip etmektedir. Boş zaman (*free time*) 0,40 kg CO₂e ile en düşük GHG emisyon yoğunluğuna sahiptir. Çalışma ve resmi eğitim faaliyetlerine ayrılan zamana ise herhangi bir tüketim ürünü ve emisyon atanmamıştır.

Saatlik GHG yoğunluğu Avusturya, Birleşik Krallık ve Japonya için sırasıyla 1,3, 1,2 ve 0,63 kg CO₂e'dir (Smetschka vd., 2019; Druckman vd., 2012; Jiang vd., 2022). Gelirdeki farklılıklar harcamalara ve dolayısıyla emisyonlara yansıdığından, ekonomik olarak gelişmekte olan bir ülke olan Türkiye'de emisyon yoğunlukları gelişmiş ülkelerdekine kıyasla daha düşüktür.

Çalışmamızın sonuçları literatürdeki diğer sonuçlarla kıyaslanmaya uygun olsa da tüketim ürünleri ile zaman kullanım aktivitelerinin eşleştirilmesinde Smetschka vd.'nin (2019) uyumluluk matrisi kullanıldığından direkt olarak Türkiye – Avusturya kıyaslaması yapmanın daha sağlıklı olduğunu düşünmekteyiz.

Türkiye ve Avusturya'nın sonuçlarını karşılaştıracak olursak; her iki ülkede de benzer boş zaman faaliyetleri en düşük GHG emisyon yoğunluğuna sahiptir. Bunlar arasında gönüllülük, okuma, evcil hayvan bakımı, spor, arkadaşlarla vakit geçirme ve TV izleme yer almaktadır. Tamirat ve bahçe işleri hariç, diğer serbest zaman faaliyetleri GHG emisyon yoğunluğu açısından aynı sıralamaya sahiptir. Tamirat ve bahçe işleri Türkiye'de GHG emisyon yoğunluğu en yüksek faaliyetlerden biri iken Avusturya'da nispeten daha az GHG emisyon yoğunluğuna sahiptir.

Ülkeler arası gelir farklılığı ortalama emisyon yoğunluğunda Avusturya aleyhine bir artışa yol açarken aynı zamanda yüksek GHG emisyonlarını etkileyen faaliyetlerin de farklılaşmasına neden olmaktadır. Avusturya'nın en GHG yoğun üç faaliyeti dışarıda yemek, eğlence ve kültür ile hobiler ve oyunlardır. Avusturya'nın en sera gazı yoğun işlevsel zaman kullanım kategorisi hareketlilik zamanıdır (4,9 kg CO₂e/h) ve bunu boş

zaman etkinlikleri (1,9 kg CO₂e/h) takip etmektedir. Avusturya'da insanlar boş zaman faaliyetlerine harcayacak daha fazla gelire sahipken, Türkiye'de saat başına en yüksek kategori yeme-içmedir. Bu durum, kişi başına düşen GSYH'nin düşük olduğu gelişmekte olan ülkelerdeki hanelerin karbon ayak izini daha da azaltmanın zorluğuna işaret etmektedir.

Avusturya'da dışarıda yemek yemenin sera gazı emisyon yoğunluğunun yeme-içmeden daha düşük olması, Türkiye'de ise tam tersi bir durumun söz konusu olması, iki ülke arasındaki farklara ilişkin bir diğer çarpıcı sonuçtur. Avusturya'daki bir kişi, Türkiye'deki bir kişiye kıyasla dışarıda yemek yiyerek geçirdiği 1 saatte yedi kat daha fazla emisyonla neden olmaktadır. Bu durum yine gelir farklılığıyla açıklanabilir. Türkiye'de bu kategorinin yoğunluğu Avusturya'dan daha düşüktür çünkü Türkiye'de insanlar dışarıda yemek için fazla para harcamamakta ve emisyon yoğunluğu yüksek ürünler tüketmemektedir. Örneğin Türkiye'de et ve şarap gibi emisyon yoğunluğu yüksek ürünlerin tüketimi gelişmiş olan ülkelerin gerisinde kalmaktadır (TEPGE, 2018; OIV, t.y.). Bu çalışmada tüm gruplar için homojen bir emisyon yoğunluğu hesaplaması yapılmış olsa da Türkiye ve Avusturya sonuçlarını karşılaştırdığımızda farklı gelir grupları için emisyon yoğunluğunun değiştiğini söylemek mümkündür. Dışarıda yemek yeme ve eğlence faaliyetlerinin yoğunluğu yüksek gelir gruplarında diğer gruplara kıyasla çok daha yüksek olacaktır. Gelecekte yapılacak bir çalışmada zaman kullanım faaliyetlerinin gelir bazlı emisyon yoğunluklarını incelemeyi umuyoruz.

Genel sonuçların ardından cinsiyet, çalışma durumu, medeni durum ve yaşa göre farklı demografik grupların zaman kullanım alışkanlıkları ve sebep oldukları günlük emisyon miktarı incelenmiştir. Medeni durum ve yaştaki farklılıklar politika önerisine katkıda bulunmadığı için sonuçlardan özetle bahsedilmeyecektir.

Cinsiyetler arası temel farklılıklar şöyle özetlenebilir:

- Ortalama olarak erkekler günde 10,88 kg CO₂e salınımı yaparken, kadınlar 11,53 kg CO₂e salınım yapmaktadır. Ev işleri zaman kullanım alışkanlıklarındaki cinsiyet rollerinin en belirgin olduğu kategoridir.

Erkeklerin bu kategorideki emisyonları toplam emisyonlarının %3,3'ünü oluştururken, kadınlarınki %15,3'tür. Kadınların günlük olarak daha fazla emisyonu neden olmalarının temel nedeni ev içi ücretsiz emeğidir.

- Erkekler ise özellikle iş amaçlı yüksek seyahat süreleri nedeniyle nispeten daha yüksek emisyonu neden olmaktadır. Boş zamanlarında, dışarıda yemek yemek gibi nispeten yüksek yoğunluklu faaliyetlere daha fazla zaman harcayarak daha yüksek emisyonlara yol açmaktadırlar.

Çalışma durumuna göre farklılıklar şöyle özetlenebilir:

- Ortalama olarak, işsiz bir kişi çalışan bir kişiye göre günlük 2,47 kg CO₂e daha fazla emisyonu sebep olmaktadır. Çalışmayanlar mobilite hariç her FTU kategorisinde daha fazla emisyonu neden olmaktadır.
- Boş zaman faaliyetleri arasında, çalışanlar sadece dışarıda yemek yeme konusunda daha fazla emisyonu neden olmaktadır. Çalışmayanlar, çalışanlara kıyasla 3 saat daha fazla boş zaman için sadece 0,5 kg daha fazla emisyonu neden olmaktadır. Bu, çalışmayanların daha az karbon yoğun boş zaman faaliyetlerine çalışanlardan daha fazla zaman ayırdığı anlamına gelmektedir.
- İşsiz erkekler en yüksek emisyonu sahipken, onları işsiz kadınlar takip etmektedir. Toplam günlük emisyonlar açısından çalışan erkekler ve çalışan kadınlar arasında bir fark yoktur.
- Hem erkekler hem de kadınlar için, çalışmayanların zaman ayırdıkları faaliyetlerden kaynaklanan emisyonları çalışanlara göre daha yüksektir. Ancak bu artış kadınlar için daha fazladır. Boş zaman faaliyetlerinden kaynaklanan emisyonlar da çalışmayanlar için çalışanlardan daha yüksektir. Ancak, aradaki fark kadınlar için daha azdır.
- İşsiz erkekler serbest zaman faaliyetleri yoluyla daha fazla emisyonu neden olurken, işsiz kadınlar taahhüt edilen zaman faaliyetleri yoluyla daha fazla

emisyonu neden olmaktadır. Ayrıca, işsiz erkekler, özellikle boş zamanlarında, bir günde çalışan kadınlar kadar seyahat etmektedir.

- Çalışan erkekler günlük olarak en az GHG emisyonuna neden olan gruptur. Ancak, çalışan erkekler 0,40 ile en yüksek dışarıda yemek yeme oranına³ sahiptir. Bu oran çalışan kadınlar için 0,35, çalışmayan erkekler için 0,17 ve çalışmayan kadınlar için 0,10'dur. Mobilite için harcanan daha yüksek zaman ve daha fazla çalışma saati, çalışan erkeklerde zaman sıkışması⁴ sorununa yol açmış olabilir.

Politika Önerileri

Bulgular bölümündeki sonuçlara dayanarak dört ana politika önerimiz vardır.

Bunlardan ilki, en yüksek sera gazı emisyon yoğunluğuna sahip olan yeme-içme faaliyeti ile ilgilidir. Türkiye'de ortalama bir kişinin günlük emisyonlarının %24'ü yeme-içmeden kaynaklanmaktadır. Dışarıda yemek yeme de dahil edildiğinde bu oran yüzde 29'a çıkmaktadır. Bu nedenle öncelik, yenilenebilir enerji kaynaklarını artırarak ve tarımda yeşil uygulamaları teşvik ederek yiyecek ve içeceklerin sera gazı yoğunluğunu azaltmak olmalıdır. Tarımda sera gazı emisyonlarının birincil kaynağı inekler tarafından üretilen metandır (Murphy vd., 2013). Üretilen metanı azaltmak için çeşitli stratejiler bulunmaktadır, ancak herhangi bir refah kaybı olmadan uygulanabilecek çözümler bulmak kritik önem taşımaktadır. Örneğin, yem takviyeleri veya sürü sağlığının iyileştirilmesi hem hayvan refahını artırabilir hem de sera gazı emisyonlarını etkili bir şekilde azaltabilir (Beauchemin vd., 2011; Llonch vd., 2017).

İkinci öneri çalışma grubunu hedeflemektedir. Yüksek çalışma saatleri ve işe seyahat süresi zaman sıkışmasına yol açarak insanların daha karbon yoğun faaliyetlere

³ Dışarıda yemek yeme süresi / toplam yemek yeme süresi

⁴ Zaman sıkışması, genellikle yüksek çalışma saatleri ve düşük iş-yaşam dengesinin kişinin boş ve ev içi zamanında sıkışmaya yol açmasını ifade eder.

yönelmesine neden olabilir.Örneğin, seyahatte zaman kazanmak için toplu taşıma yerine özel araç kullanmak veya evde yemek pişirmek yerine fast food tüketmek bu sorunun sonuçları olabilir. Dışarıda yemek yeme süresinin çalışan erkeklerde diğer gruplara göre daha yüksek olması buna işaret ediyor olabilir. Çalışma saatlerinin kısaltılması, uzaktan çalışmanın yaygınlaştırılması ve toplu taşıma sistemlerinin iyileştirilerek daha kullanışlı hale getirilmesi başlıca önerilerimizdir. Ayrıca özellikle İstanbul gibi nüfus yoğunluğu yüksek şehirlerde insanlar trafikte vakit kaybetmektedirler (Gürsoy vd., 2016). Ayrıca trafikte geçirilen zamanda mobilite kaynaklı emisyonu da sebep olmaktadır. Bu konudaki önerimiz tersine göçün teşvik edilmesi ve kümelenmiş sanayi merkezlerinin farklı şehirlere yayılmasıdır.

Üçüncü hedef grup ise kadınlardır. Kadınların temizlik, bulaşık, yemek, çocuk ve yaşlı bakımı gibi ücretsiz ev içi emeğe harcadıkları zaman erkeklere kıyasla çok yüksektir. Özellikle çalışmayan kadınlar neredeyse tam zamanlı bir iş kadar zaman harcamaktadır. Çalışan kadınlar da bu işleri ikinci vardiya olarak üstlenmektedir. Kadınlar hem bu faaliyetler nedeniyle yüksek emisyonu neden olmakta hem de olası bir zaman sıkışması sorunuyla karşı karşıya kalmaktadır. Burada yerel yönetimlere önemli bir rol düşmektedir. Özellikle düşük sosyo-ekonomik bölgelerde çocuk ve yaşlı bakım hizmetleri ve ilköğretim çocukları için yemek sağlanması, kadınların üzerindeki yükü azaltacak ve kadınlara daha düşük yoğunluklu boş zaman faaliyetlerine ayırabilecekleri zaman bırakacaktır. Bu hizmetler, ölçek ekonomileri sayesinde toplam emisyonların azaltılmasına da yardımcı olacaktır. Çocuk bakımı nedeniyle çalışmayan kadınlar işgücüne yeniden entegre edilebilir ve bu da ekonomik bir katkı olacaktır. Uzun vadede, eğitim ve farkındalık artırma faaliyetleri yoluyla toplumsal cinsiyet eşitsizliğinin giderilmesi ve çevre yükünün adil paylaşımı için çaba gösterilmelidir.

Dördüncü ve son hedef grubu çalışmayan erkeklerdir. Boş zaman aktivitelerinde ve bu amaçla seyahat edilen zamanda diğerlerine göre daha yüksek emisyonu neden olmaktadır. Özellikle büyük şehirlerde kültür ve eğlence faaliyetlerinin şehrin belirli merkezlerinde yoğunlaşması, uzak semtlerden bu yerlere seyahatte zaman kaybına neden olabilmekte ve seyahat kaynaklı emisyon artmaktadır. Bu nedenle sosyo-kültürel açıdan az gelişmiş bölgeler tespit edilmeli ve park, kütüphane, tiyatro

gibi tesisleri yaygınlaştırmalıdır. Özellikle kentsel yeşil alanlar en ucuz ve en çevre dostu alternatiftir. Ayrıca, bu tür faaliyetler devlet tarafından sübvansede edilmelidir. Bu sayede sadece çalışmayan erkekler değil, tüm toplum boş zamanlarını yakın, kaliteli ve çevre dostu düşük sera gazı emisyon yoğunluğuna sahip aktivitelerle geçirebilir.

Kısıtlar

Çalışmadaki temel zorluk üç farklı veri setini bir araya getirmekten doğmaktadır. Bu veri setlerini bir arada kullanabilmek oluşturduğumuz dönüşüm tablolarını oluşturmak için literatürde genel geçer bir yöntem olmaması başlıca limitimiz. EXIOBASE-COICOP dönüşüm tablosunu oluştururken ortaya çıkan bir kısıt EXIOBASE harcamalarının temel fiyat, hanehalkı tüketim harcamalarının tüketici fiyatı cinsinden olmasıdır. Hanehalkı bütçe anketindeki tüketim ürünlerinin vergi, ticaret ve lojistik marjlarını bilmediğimizden; bu ürünlerin tüketim harcamalarını temel fiyat cinsinden hesaplayamıyoruz. Bu noktada, ürünler arasındaki vergi, ticaret ve lojistik marjı farkının önemsiz olduğunu varsayarak dönüşüm tablosunu hazırladık.

Zaman kullanım anketi sadece 10 yaş üstü bireyleri kapsamaktadır. Ancak, hesaplanan emisyonlar tüm nüfus içindir. Kişi başına düşen emisyonları kişi başına düşen zaman kullanımına bölerek iki veri setini eşleştiriyoruz. Sonuç olarak, örneğin on yaşın altındaki çocukların tükettiği gıdalardan kaynaklanan emisyonları on yaşın üzerindeki bireylere atıyoruz. Benzer şekilde, çocukların bulaşık veya çamaşır yıkamasından kaynaklanan emisyonlar da yetişkinlere atanıyor. On yaşından küçük çocuklar tarafından tüketilen yiyecek ve giyecek miktarına genellikle ebeveynleri karar verdiği için bu yaklaşımın makul olduğuna inanıyoruz.

Çalışmada faaliyet yoğunluğun faaliyet süresiyle orantılı hesaplanmış ve herkes için aynı olduğunun varsayılmıştır. Tüketim alışkanlıkları özellikle farklı gelir gruplarında değişiklik gösterdiğinden, bir saat içinde aynı faaliyetten kaynaklanan emisyon miktarı da farklılık gösterecektir ancak çeşitli yaşam tarzlarının alışkanlıklarını modele tam olarak yansıtmak mümkün olmadığından, homojen bir emisyon yoğunluğu varsayılmıştır. Gelecek çalışmalarda, farklı gelir grupları için farklı emisyon yoğunlukları tahmin etmeyi umuyoruz.

Sonuç

Bu çalışmada, karbon ayak izlerini azaltmaya yönelik talep yönlü öneriler sunmak amacıyla Türkiye'deki hanelerin sera gazı emisyonlarını zaman kullanımı perspektifinden inceledik. Ayrıntılı bir uyumluluk matrisi oluşturarak doğrudan ve dolaylı emisyonları 67 COICOP ürününe tahsis ettik ve bu emisyonları 21 zaman kullanım faaliyetine dağıttık. Bulgular, Türkiye'deki ortalama sera gazı yoğunluğunun saat başına 0,47 kg CO₂e olduğunu ve bunun gelişmiş ülkelere kıyasla önemli ölçüde düşük olduğunu ortaya koymaktadır. Yeme ve içme, sera gazı yoğunluğu en yüksek faaliyetler olarak tespit edilmiş ve sürdürülebilir tarım uygulamalarına duyulan ihtiyaç vurgulanmıştır.

Uzun çalışma saatleri ve işe gidip gelme nedeniyle hem çalışan erkeklerde hem de ücretsiz ev içi emek nedeniyle kadınlarda, daha az çevre dostu alternatiflere yönelmeye sebep olacak zaman sıkışması problemi tespit ettik. Çalışma saatlerinin azaltılmasını, uzaktan çalışmanın teşvik edilmesini, ulaşım altyapısının iyileştirilmesini ve kadınların ev içi yükünü hafifletmek için ölçek ekonomilerinin uygulanmasını, örneğin kreş ve yaşlı bakım hizmetlerinin sağlanmasını önermekteyiz. Ayrıca boş zaman faaliyetleri sırasında yüksek emisyonlara katkıda bulunan işsiz erkekler, özellikle sosyo-kültürel açıdan dezavantajlı bölgelerde parklar gibi çevre dostu kamusal alanların yaygınlaştırılmasından faydalanabilir; düşük emisyon yoğunluğuna sahip boş zaman aktivitelerinin devlet tarafından sübvansede edilmesiyle toplumdaki tüm bireylerin karbon ayak izi azaltılabilir.

Türkiye'nin zaman kullanımı ayarlamaları yoluyla emisyon azaltma fırsatları gelişmiş ülkelere kıyasla sınırlı olsa da iklim değişikliğiyle mücadele için devam eden çabalar önemini korumaktadır ve bu çalışma hem makro hem de mikro düzeyde uygulanabilir politika önerileri sunmaktadır.

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