PHYSICAL INACTIVITY DURING PREGNANCY: ITS ASSOCIATIONS WITH SOCIO-DEMOGRAPHIC BACKGROUND AND MENTAL HEALTH[1]

Nikolett Gabriella Sándor – Julianna Boros – Krisztina Kopcsó – Beatrix Lábadi

ABSTRACT

Exercise during pregnancy is known to have positive effects on both maternal and foetal health. Despite international recommendations advocating regular exercise for healthy pregnant women, survey data indicate that physical activity decreases during pregnancy, particularly in the third trimester. This study aims to assess the physical activity levels of pregnant women in Hungary in a representative sample and to explore the association between physical inactivity, socio-demographic characteristics, and mental health. Utilizing data from the Cohort '18 Hungarian Birth Cohort Study, our analysis encompasses 6,121 pregnant women. Maternal physical activity was assessed in the third trimester, both for the time of the interview and retrospectively for the pre-

[1] The Cohort '18 Growing Up in Hungary research was financed within the framework of the EFOP-1.9.4.–VEKOP-16-2016-00001 invitation (Renewing methodology and informatics in the social sector), issued by the Hungarian Ministry of Human Capacities.
We would like to thank all the health visitors and the mothers who participated in the Cohort '18 Growing Up in Hungary research. Furthermore, we would like to thank Róbert Urbán for his invaluable methodological advice provided for the analysis.

pregnancy period. Mental health was evaluated through the CES-D-8 and GAD-2 questionnaires. The inactivity rate (defined as less than 1 hour per week) in the third trimester was 70% for walking, 92% for cycling, and 90% for sports. Inactivity increased across all forms of physical activity during pregnancy. The socio-demographic determinants influencing physical activity during pregnancy varied for different activities. The examined socio-demographic variables explained 3.5–4.7% of the variance in walking, 3.3–7.8% in cycling, and 7–14% in doing sport during pregnancy. Mental health was only significantly associated with sport activity. These findings underscore the importance of raising awareness about physical activity in antenatal care, particularly targeting at-risk populations.

Keywords: pregnancy, physical activity, socio-demographic background, mental health

Nikolett Gabriella Sándor
Department of Personality and Clinical Psychology, Institute of Psychology, Pázmány Péter Catholic University, Budapest, Hungary; Doctoral School of Psychology, University of Pécs, Hungary
E-mail: sandor.nikolett.gabriella@btk.ppke.hu

Julianna Boros
Hungarian Demographic Research Institute; Institute of Behavioural Sciences, Faculty of Medicine, Semmelweis University, Budapest, Hungary
E-mail: boros@demografia.hu

Krisztina Kopcsó
Hungarian Demographic Research Institute; Department of Developmental and Clinical Child Psychology, Institute of Psychology, Pázmány Péter Catholic University, Budapest, Hungary
E-mail: kopcso@demografia.hu

Beatrix Lábadi
Department of Cognitive and Evolutionary Psychology, University of Pécs
E-mail: labadi.beatrix@pte.hu

INTRODUCTION

EXERCISE DURING PREGNANCY

Physical activity (PA) is defined as exercise that involves movement of the skeletal muscles that requires energy expenditure. This encompasses a diverse array of activities, such as movement during various leisure activities, transportation, and even work. Regular PA at moderate to high intensity has been established to yield favourable health outcomes (Mottola et al., 2018). There are guidelines for prescribing exercise in specific populations and age groups (World Health Organization, 2022). One such distinctive life situation that merits consideration is pregnancy (Davenport et al., 2018).

During pregnancy, the body undergoes numerous changes (Dagher et al., 2021; Soma-Pillay et al., 2016). However, exercise is recommended during pregnancy unless there is any medical contraindication (e.g. high-risk pregnancy) (Peters & Brazeau, 2019).

The American College of Obstetricians and Gynecologists (ACOG) recommends that pregnant women should get at least 150 minutes of moderate-intensity exercise per week. ACOG recommends at least 20–30 minutes of exercise on most or all days of the week (see ACOG Opinion Committee, 2020).

PA during pregnancy may prevent excessive gestational weight gain (Ruchat et al., 2018; Watson et al., 2018), gestational diabetes (Dipla et al., 2021; Laredo-Aguilera et al., 2020; Peters & Brazeau, 2019), high neonatal birth weight – also known as macrosomia – (Nguyen & Ouzounian, 2021), and gestational hypertension (Magro-Malosso et al., 2017; Witvrouwen et al., 2020; Yeo et al., 2000). Excessive gestational weight gain, gestational diabetes and macrosomia are often related (Davenport et al., 2018).

PA during pregnancy may also exert a positive effect on the wellbeing of the future baby (Mudd et al., 2013; Nascimento et al., 2015).

Previous international research has demonstrated a general decline in PA during pregnancy (Borodulin et al., 2008), a trend that becomes particularly pronounced in the third trimester (Downs et al., 2012). A 2014 study conducted in the United States revealed that only 32% of pregnant women met recommended levels of exercise in the early stages of pregnancy. This rate fell further to 12% in late pregnancy (Ruifrok et al., 2014). Similarly, a study of PA patterns among pregnant women in Singapore also revealed a decreasing trend in PA

frequency across the trimesters of pregnancy (Padmapriya et al., 2015). Another study of Chinese women found that only 11.1% of pregnant women exercised at the recommended level (Zhang et al., 2014).

Results from an extensive cohort study found that nearly 60% of New Zealand women maintained an active lifestyle during their pregnancy. Among those who were physically active, 40% decreased the amount of activity during the first trimester and a subsequent 30% further reduced PA in the later trimesters. Notably, only 4% of the initially inactive mothers started the recommended level of activity in the first trimester of pregnancy. The researchers concluded that the probability of women who were inactive before pregnancy getting the right amount of exercise and becoming active during pregnancy was negligible (Morton et al., 2010).

A large-sample cohort study in Denmark also assessed pregnant women's frequency of exercise. The study of nearly 8,000 participants shows that 38% of Danish mothers adhered to the recommended exercise guidelines in early pregnancy. The study found that the four most popular forms of exercise in early pregnancy were cycling, running, walking and strength training. In early pregnancy, 30% of women cycled, 22% did brisk walking, 10% ran and 8% performed strength training (Broberg et al., 2015).

A Spanish study found that 20.3% of pregnant women at 20 weeks' gestation met the ACOG recommendation for PA (Amezcua-Prieto et al., 2011).

Results from a cohort study that was conducted in Norway between the 17th and 21st gestation weeks found that 14.6% of pregnant women exercised the adequate amount during pregnancy. The study used the Norwegian recommendations of at least 20 minutes of moderate-intensity PA three times a week as a reference. 31.3% of the women in the study did less than one session of PA per week (Gjestland et al., 2013).

International results show similarly low levels of PA during pregnancy. However, detailed comparisons of the results are complicated because the studies used different measurement methods, examined women in different trimesters of pregnancy and in some cases referred to national rather than international recommendations, making it difficult to interpret the results.

Except for the Cohort '18 Hungarian Birth Cohort Study discussed in the present paper, no previous representative study has specifically investigated data on the frequency of PA during pregnancy in Hungary. According to the 2014 European Health Interview Survey, 15% of men and 10% of women exercise at least 150 minutes a week, based on the PA of the total Hungarian population (Bíró & Tokaji, 2018). The 2019 wave of the European Health Interview

Survey found that three out of ten Hungarian adults exercised in their leisure time in line with the World Health Organization (WHO) recommendations for PA for adults (Hungarian Central Statistical Office, 2019).

Drawing on insights from global findings, we expect the overall level of PA to decrease during pregnancy among women in Hungary.

EXERCISE AND MENTAL HEALTH

In mood disorders, female gender is associated with increased sensitivity (American Psychiatric Association, 2013). The multifaceted physical (Soma-Pillay et al., 2016), psychological (Meltzer-Brody & Stuebe, 2014) and social (Slomian et al., 2019) transformations during pregnancy and childbirth can impose significant challenges on women going through this period. Notably, depression emerges as a frequent serious complication during pregnancy (Dagher et al., 2021). Peripartum depression, i.e. depression during pregnancy, childbirth and the puerperium, is a condition affecting up to one in seven women, according to international data (Langan & Goodbred, 2016). A large-sample study in the Netherlands found that 4% of women experienced symptoms of depression in each trimester of pregnancy. Perinatal depression in any trimester was associated with previous mental health problems, multiparity and unplanned pregnancy (Truijens et al., 2017).

Many women also experience anxiety during the antenatal period because, as mentioned above, pregnancy brings about many changes. Anxiety is a normal emotional response, but it can become abnormal if it is exaggerated and interferes with the mother's daily life. Anxiety symptoms can have negative effects on both the mother and the foetus (Ding et al., 2014; Rubertsson et al., 2014). Perinatal anxiety may be caused by generalised anxiety disorder.

Antenatal depression and anxiety may go unnoticed, often resulting in a lack of treatment. This happens because depressive symptoms may be found among the many changes associated with pregnancy, leaving pregnant women and professionals to identify depressive symptoms with the transient changes associated with pregnancy. These symptoms typically include weight changes, appetite changes and sleeping problems (Coates et al., 2004). Depression and anxiety in the peripartum period have negative effects on both the child and the mother (Ruchat et al., 2018; Waters et al., 2014; Weinstock, 2005). In particular, depression or anxiety disorder during pregnancy increase the likelihood of developing postpartum depression (Underwood et al., 2016).

Several previous studies have examined the association between PA and mental health during the perinatal period. A meta-analysis (Daley et al., 2015) identified significant reductions in depression scores attributable to exercise. However, the strength of these associations was found to be weak to moderate. A systematic review revealed that exercise during pregnancy reduced the odds of depression during pregnancy and mitigated the severity of the symptoms (Davenport et al., 2018). However, this beneficial effect did not extend to the postpartum period, and no association was found for anxiety in either the peri- or postnatal period. Sánchez-Polán and colleagues (2021) examined the effect of PA on the development of perinatal depression. Reviewing 15 studies, they found that physically inactive women were 16% more likely to develop perinatal depression and identified a negative association between depression and PA. The authors highlighted that all the reviewed studies examined healthy pregnant women, which enabled them to examine the onset of depressive symptoms but not the diagnosed depression and its impact. He et al. (2023) filled the gap of previous studies by conducting a meta-analytic study on the effect of exercise on depression. The uniqueness of this study is that both the level and duration of PA were included in the analysis. Their findings indicated that moderate exercise may decrease the risk of postpartum depression in the general pregnant population. They also found that both low and moderate intensity exercise had a positive effect on symptoms in women with postpartum depression.

According to the literature, the relationship between exercise and maternal mental health during pregnancy is complex (Takahasi et al., 2013). PA has a preventive effect on the development of mental problems (Goodwin, 2003; Mortazavi et al., 2012; Saxena et al., 2005), and PA can serve as an intervention to treat mental disorders (Conn, 2010; Dinas et al., 2011; Singh et al., 2023). Furthermore, lower levels of maternal mental health are associated with increased inactivity during pregnancy. This association may be attributed to the physical effort required by PA, which can be more challenging for mothers with poorer mental health, along with a potential decrease in their motivation to engage in exercise (Poudevigne & O'Connor, 2006; Takahasi et al., 2013).

EXERCISE AND SOCIO-DEMOGRAPHIC BACKGROUND

Several studies on individual differences in exercise during pregnancy examined the role of socio-demographic background of pregnant women. The ef-

fects of education and household income on PA during pregnancy were identified. Studies have consistently confirmed that higher maternal education and higher household income are associated with more frequent PA during pregnancy (Fell et al., 2009; Gebregziabher et al., 2019; Larrañaga et al., 2013; Nascimento et al., 2015; Petersen et al., 2005). Larrañaga and colleagues (2013), comparing results of four cohort studies on pregnant women, found that inactivity rates were higher among mothers from low socio-demographic backgrounds. In a review study, Gaston and Cramp (2011) summarized the findings of 25 studies and identifies socio-demographic characteristics such as higher level of maternal education, household income, pre-pregnancy PA and having no children currently in the household as predictors of higher PA. However, there is a lack of consistency in the research results in terms of parity. Some studies found that primiparity was associated with lower levels of PA (Gebregziabher et al., 2019; Syed Nor et al., 2022), while others identified relationship between inactivity and multiparity (Davenport et al., 2018; Gaston & Cramp, 2011). Further research (Alghamdi, 2023) using structured interviews showed that age, body mass index and work status were also important predictors of PA during pregnancy.

Based on Hungarian population survey data, PA (not including walking and cycling) is associated with socio-demographic characteristics. More than half of individuals in the top income quintile and those with a tertiary degree perform the recommended amount of exercise per week, compared to only one-fifth of those in the bottom income quintile, women with up to eight years of primary education and men with vocational education (Bíró & Tokaji, 2018).

To date, no representative study has specifically investigated data on PA during pregnancy and its associations in Hungary. Given the risks associated with physical inactivity during pregnancy, the aim of this study is to assess the PA levels of pregnant women in Hungary using a representative sample of the Cohort '18 Hungarian Birth Cohort Study. Additionally, this study seeks to explore the association of socioeconomic status and mental health with physical inactivity during pregnancy.

METHODS

DESIGN AND SAMPLE

The present study analyses data from the first, prenatal wave of the Cohort '18 Hungarian Birth Cohort Study (abbreviated as Cohort '18), conducted by the

Hungarian Demographic Research Institute.[2] Cohort '18 is a longitudinal cohort study designed to examine a representative sample of children growing up in Hungary. The research adopts a multidisciplinary approach, with a particular focus on demographic characteristics, social, health-related, developmental and psychological factors. The study population consists of Hungarian mothers whose children were expected to be born between 1 April 2018 and 30 April 2019. Recruitment and data collection were conducted via the network of health visitors, who received preliminary training. In Hungary, the health visitor service provides an obligatory health service as part of the antenatal care. The one-time state allowance that mothers receive at the birth of their child is conditional on attending antenatal care. If the pregnant woman refuses to cooperate with the health visitors, they must report this to child protection services. They are responsible for following the pregnancy and examining pregnant women, and thus they are competent to assess the health or social risk of pregnancy.

The study sample is considered to be representative of the population of women giving birth in Hungary in 2018 in terms of maternal age, education, official marital status, place of residence and parity.

The research complied with both the Code of Ethics for Hungarian Psychologists and the Declaration of Helsinki. In addition to prior verbal information, participants were provided with written information on data protection and data management in all cases. Participation in the research was based on voluntary informed consent, which was signed in writing by the subjects (or by their legal guardian for participants under 18 years of age). Details of the legislation and the research are described in published technical reports (Szabó, 2021; Veroszta, 2018, 2019).

In the first wave of the study, pregnant women were contacted during the third trimester of their pregnancy (gestational weeks 28–31) by health visitors. In some cases (n = 1668, percentage = 20.2%, minimum = 20th week, maximum = 40th week), the data were collected outside the specified gestational interval. In the present analysis, respondents beyond gestational weeks 28–31 are excluded to improve the interpretability of the data. We also exclude multiple pregnancies, as they are considered as pregnancies at risk (Buhling et al., 2003) (twin pregnancy n = 120, percentage = 1.45%; triplet pregnancy = 1, percentage = 0.01%). The total number of participants is 6,121. We have not applied data replacement for missing data, so the sample size may vary.

[2] The public database of the study is available on reasonable request from the Hungarian Demographic Research Institute.

MEASURES

Socio-demographic and pregnancy-related data

In the analysis, socio-demographic and pregnancy-related data were used from the prenatal wave of the Cohort '18 survey (grouping certain categories together for the purposes of this analysis) and from the linked data of the Pregnancy Booklet, provided by health visitors with maternal consent.

The analysed socio-demographic background variables were maternal age (14–19; 20–24; 25–29; 30–34; 35–39; 40+ years), highest maternal educational attainment (up to 8 years of primary schooling; vocational training; secondary education; higher education), equivalent income quintiles[3] (1 = lowest; 5 = highest), parity (first child of the mother; not the first child), the population of settlement (up to 1,000; 1,001–4,999; 5,000–19,900; 20,000–49,999; 50,000–1,000,000 inhabitants; Budapest (capital of Hungary)), and work status[4] (unemployed; employed).

Regarding maternal health status, the analyses included pregnancy risk classification and mothers' subjective health assessment. The risk classification of pregnancy was based on the opinion of the local health visitors, as indicated by the official classification of mothers' pregnancy risk in the Pregnancy Booklet (need extra pregnancy care for health or social reasons; no need for extra care). The subjective health rating was measured on a Likert scale of 1 to 5 for the mother's assessment of her health (1 = very good; 5 = very poor).

Depressive symptoms

Depressive symptoms were assessed using an 8-item version (Bracke et al., 2008) of the Center for Epidemic Studies Depression questionnaire (Radloff, 1977) (CES-D-8). The Hungarian translation of the questionnaire was done by Szeifert (2010). In the questionnaire, respondents indicate on a 4-point Likert scale how often they have experienced certain feelings or behaviour in the past week (0 = None or almost none of the time (less than one day), 3 = All or almost all of the time (5–7 days)). A higher score indicates a higher frequency of depressive experiences. The internal consistency of the scale was found to be good throughout the study (Cronbach's alpha = 0.755). Questions about depressive experiences were included in the self-administered paper-pencil

[3] The means of net monthly equivalent income, divided into equalised household income quintiles, calculated on the total sample. This is based on a square-root equivalence scale, following OECD practice.

[4] Based on employment, regardless of whether the woman is actively working or already on maternity leave.

questionnaire. Following the previous literature in Hungary (Kopcsó, 2020), the cut-point for CES-D-8 was set at ≥ 9, based on the stricter cut-off.

Generalised anxiety

Generalised anxiety was measured using the Generalised Anxiety Disorder-2 scale (GAD-2) (Kroenke et al., 2007). The questionnaire can be used to screen anxiety symptoms. The measure uses a 4-point Likert scale (0 = Not at all; 3 = Nearly every day) to reveal how often the respondent's certain behaviour and feelings occurred over the past two weeks. The questionnaire consists of two items. The minimum score obtainable on the test is 0 and the maximum is 6. The higher the score, the more anxiety symptoms the respondent reports.

The measure is suitable for screening for generalised anxiety disorder, also in the population of pregnant women (National Institute for Health and Care Excellence, 2014). The questionnaire was found to be reliable (Cronbach's alpha = 0.702) in the Cohort '18 study. The assessment of generalised anxiety was part of the self-administered paper-pencil questionnaire. Following the previous literature in Hungary (Kopcsó, 2020), the GAD-2 cut-off point was defined at ≥ 3.

Physical activity

PA during pregnancy was measured in the third trimester, as well as retrospectively for the pre-pregnancy period. A 4-point scale (1 = Not at all; 2 = Less than an hour; 3 = More than one but less than three hours; 4 = At least three hours) was used to indicate the mean duration of weekly PA of the mothers during these periods. The following activities were assessed: 1) physical activity, such as swimming, running, aerobics, and tennis (referred to henceforth as sport); 2) cycling, including cycling to work and outdoor activity; and 3) walking, including walking to work. The computer- or paper-assisted personal interviews were assisted by local health visitors (Szabó, 2021). For the analysis, the original four response categories of frequency have been merged into two categories (less than one hour per week; at least one hour per week). The cut-off point for PA during pregnancy is at least one hour per week. Thus, pregnant women who exercised less than one hour per week during the 28–31 weeks of gestation were included in the inactive category.

DATA ANALYSIS

For the categorical variables, we report their frequencies and percentages. The CES-D-8 and GAD-2 scores were transformed from continuous to categorical variables. The four categories of the distress variable consisted of depressive and anxiety symptoms. *Sine morbo* meant the absence of these symptoms. The depressive symptoms category indicated a high-risk score only on the CES-D-8 scale, while anxiety symptoms indicated a high-risk score on the GAD-2 questionnaire. The comorbidity category included those who had both symptoms together.

The Pearson chi-square test was used to calculate the difference in the exercise frequency before and during pregnancy. Effect sizes are reported using Phi indices.

Firstly, three binary logistic regression models were applied for the multivariate analysis with activity as the dependent variable in the three PA forms (sports, walking, and cycling). The predictor variables included in the model were socio-demographic background variables, namely maternal age, equivalent income quintiles, population of settlement, highest maternal educational attainment, parity, and work status.

For the final model, we also used binary logistic regression analysis, in which we added the distress variable as an additional predictor. The independent variables were analysed using the ENTER method. In order to control for maternal health status, the model included pregnancy risk classification and mothers' subjective health assessment. We reported odds ratios and corresponding 95% confidence intervals (CI).

The accepted significance level was $p < 0.05$. Data was weighted for the statistical analysis in order to eliminate minor biases in the sample. Details of the weighting method is described in the technical report of Szabó (2021).

RESULTS

CHARACTERISTICS OF PARTICIPANTS

The maternal characteristics included in this study are presented in *Table 1*.

Table 1: Descriptive characteristics of respondents

Maternal characteristics	*N* (%)
Age (*N* = 6121)	
14–19 years	333 (5.4)
20–24 years	918 (15.0)
25–29 years	1620 (26.5)
30–34 years	1854 (30.3)
35–39 years	1087 (17.8)
40+ years	309 (5.1)
Educational attainment (*N* = 6121)	
Up to 8 years of primary schooling	1230 (20.1)
Vocational training	732 (12.0)
Secondary education	2103 (34.3)
Higher education	2057 (33.6)
Equivalent income quintiles (*N* = 5498)	
1 (lowest)	1101 (20.1)
2	1102 (20.1)
3	1094 (19.9)
4	1159 (21.1)
5 (highest)	1028 (18.7)
Relationship status (*N* = 6121)	
Married	3321 (54.2)
Cohabiting	2581 (42.2)
Single/LAT	219 (3.6)
Parity (*N* = 6105)	
First child	2831 (46.4)
Second child	2018 (33.1)
Third child	870 (14.3)
Fourth or subsequent child	386 (6.3)
Population of the settlement (*N* = 6121)	
Up to 1,000 inhabitants	633 (10.3)
1,001–4,999 inhabitants	1739 (28.4)
5,000–19,999 inhabitants	1252 (20.5)
20,000–49,999 inhabitants	595 (9.7)
50,000–1,000,000 inhabitants	920 (15.0)
Budapest	983 (16.1)
Employment status (*N* = 6121)	
Unemployed	1695 (27.7)
Employed	4426 (72.3)
Self-perceived health (*N* = 5774)	
Very good	1567 (27.1)
Good	3390 (58.7)
Fair	754 (13.1)
Poor	55 (1.0)
Very poor	9 (0.1)
Need for extra pregnancy care (*N* = 6080)	
Yes, for health reasons	2228 (36.6)
Yes, for social reasons	230 (3.8)
Yes, for health and social reasons	230 (3.8)
No need for extra care	3392 (55.8)

Source: Cohort '18 Hungarian Birth Cohort Study, prenatal wave, authors' own calculations.

The mean gestation age of pregnancy at the time of the survey was 29.5 weeks (*SD* = 1.09). The mean age of mothers at birth was 29.7 years (*SD* = 6.02). 56.8% of the respondents belonged to the 25–34 age group. In terms of educational attainment, one third of mothers had tertiary education, one third had completed secondary education, while the lowest level of education, eight grades or less, was found in one fifth of mothers.

Just over half of them were married, slightly fewer were in a cohabiting partnership, with only 3.6% single or living apart together (LAT). Almost half of the participants' children in the survey were the first of their mother. One in ten respondents lived in settlements with fewer than 1,000 inhabitants, while one in six mothers lived in the capital. According to the health visitors' opinion, more than one out of three mothers needed extra pregnancy care for health reasons.

PHYSICAL ACTIVITY LEVELS

Table 2 shows the PA levels among the participants, classified into domains and duration per week, before and during pregnancy. We examined three types of physical activities: walking, biking, and sport.

Two thirds of the respondents used to walk, more than one out of four used to bike, and one third used to do some kind of sports at least 1 hour per week before pregnancy. A significant decrease can be observed in all three areas during pregnancy, with medium to large effect sizes. While the majority maintained their walking activity, the decrease in cycling and sports was remarkable.

Table 2: Physical activity levels before and during pregnancy

Physical activity levels among respondents	*N* (%)
Walking	
before pregnancy (*N* = 6121)	
less than 1 hour/week	2036 (33.4)
at least 1 hour/week	4068 (66.6)
during pregnancy (*N* = 6105)	
less than 1 hour/week	2493 (40.8)
at least 1 hour/week	3613 (59.2)
Pearson χ^2	3130.520**
Phi	0.716
Biking	
before pregnancy (*N* = 6106)	
less than 1 hour/week	4440 (72.7)
at least 1 hour/week	1666 (27.3)
during pregnancy (*N* = 6103)	
less than 1 hour/week	5607 (91.9)
at least 1 hour/week	497 (8.1)
Pearson χ^2	1240.351**
Phi	0.451
Sport	
before pregnancy (*N* = 6103)	
less than 1 hour/week	4135 (67.7)
at least 1 hour/week	1968 (32.3)
during pregnancy (*N* = 6107)	
less than 1 hour/week	5487 (89.8)
at least 1 hour/week	620 (10.2)
Pearson χ^2	1036.705**
Phi	0.412

Note: Significance levels: * $p < 0.05$, ** $p < 0.001$.
Source: Cohort '18 Hungarian Birth Cohort Study, prenatal wave, authors' own calculations.

MENTAL HEALTH PROBLEMS

Table 3 shows the prevalence of mental health problems among the respondents. Based on self-report, three quarters of the mothers had no mental health problems. Every sixth mother showed depressive symptoms, and a similar rate had anxiety symptoms. As many respondents were affected by both mental health problems, we can observe a 7.7% prevalence of comorbidity.

Table 3: Self-reported mental health problems among pregnant mothers

Mental health problems among respondents	*N* (%)
Depression symptoms (*N* = 6121)	
Yes	941 (15.8)
No	5027 (84.2)
Anxiety symptoms (*N* = 6121)	
Yes	912 (15.5)
No	4981 (84.5)
Distress (*N* = 6121)	
Sine morbo	4498 (76.7)
Depression symptoms only	462 (7.9)
Anxiety symptoms only	452 (7.7)
Comorbidity	453 (7.7)

Source: Cohort '18 Hungarian Birth Cohort Study, prenatal wave, authors' own calculations.

DETERMINANTS OF PHYSICAL ACTIVITY DURING PREGNANCY

In order to explore the sociodemographic background of physical inactivity during pregnancy, three initial models were constructed, separately for walking, cycling, and sport. In all three cases, the outcome variable was whether the pregnant woman engaged in the activity for at least 1 hour per week. The explanatory variables were maternal age, education, parity, employment status, household income, and population of the settlement.

All three initial logistic regression models were found to be significant (walking: $-2LL = 7195.36$; $\chi^2(19) = 192.79$; $p < 0.001$; cycling: $-2LL = 2872.16$; $\chi^2(19) = 185.02$; $p < 0.001$; sport: $-2LL = 3234.77$; $\chi^2(19) = 386.71$; $p < 0.001$).

The examined socio-demographic variables explained 3.5–4.7% of the variance in walking, 3.3–7.8% in cycling, and 7–14% in doing sport during pregnancy.

Overall, household income, maternal educational attainment, parity, and the population of the settlement were found to be statistically significant in the models for walking and doing sport during pregnancy. In contrast, maternal education, employment status, and the population of the settlement had significant predictive power in the models for cycling during pregnancy. Maternal age was not significant in either model.

The model values are presented in detail in *Tables 4–6*.

Table 4: Logistic regression to determine factors associated with walking activity during pregnancy

	B	*S.E.*	*OR*	CI 95%		*p*
Equivalent income quintiles						0.003*
1 (lowest)	−0.258	0.111	0.772	0.621	0.961	0.020
2	−0.283	0.102	0.753	0.617	0.920	0.005
3	−0.076	0.097	0.927	0.766	1.121	0.434
4	0.045	0.094	1.046	0.870	1.257	0.635
5 (highest; ref.)						
Maternal age						0.059
14–19 years	0.282	0.199	1.326	0.897	1.959	0.157
20–24 years	0.286	0.158	1.331	0.977	1.815	0.070
25–29 years	0.117	0.143	1.124	0.848	1.488	0.416
30–34 years	0.035	0.141	1.036	0.785	1.366	0.805
35–39 years	−0.061	0.148	0.941	0.704	1.258	0.681
40+ years (ref.)						
Population of the settlement						0.000**
Up to 1,000 inhabitants	−0.867	0.120	0.420	0.332	0.531	0.000
1,001-4,999 inhabitants	−0.808	0.098	0.446	0.368	0.540	0.000
5,000-19,999 inhabitants	−0.566	0.100	0.568	0.467	0.691	0.000
20,000-49,999 inhabitants	−0.527	0.119	0.590	0.468	0.745	0.000
50,000–1,000,000 inhabitants	−0.254	0.107	0.776	0.629	0.957	0.018
Budapest (ref.)						
Educational attainment						0.018*
Up to 8 years of primary schooling	−0.357	0.114	0.700	0.560	0.875	0.002
Vocational training	−0.179	0.106	0.836	0.679	1.030	0.092
Secondary education	−0.149	0.074	0.861	0.745	0.996	0.043
Higher education (ref.)						
Employment status						
Unemployed	0.013	0.081	1.014	0.865	1.188	0.868
Employed (ref.)						
Parity						
First child of the mother	−0.191	0.063	0.826	0.730	0.935	0.002*
Not the first child (ref.)						
Constant	1.170	0.157	3.221			0.000**

Notes: Abbreviations: OR – odds ratio, CI – confidence interval; ref. – reference category. Significance levels: * $p < 0.05$, ** $p < 0.001$.

Source: Cohort '18 Hungarian Birth Cohort Study, prenatal wave, authors' own calculations.

Table 5: Logistic regression to determine factors associated with cycling activity during pregnancy

	B	*S.E.*	*OR*	CI 95%		*p*
Equivalent income quintiles						0.122
1 (lowest)	0.344	0.220	1.410	0.917	2.169	0.118
2	0.537	0.206	1.711	1.142	2.563	0.009
3	0.360	0.204	1.433	0.961	2.138	0.078
4	0.300	0.202	1.350	0.909	2.006	0.137
5 (highest; ref.)						
Maternal age						0.347
14–19 years	–0.271	0.352	0.763	0.383	1.520	0.441
20–24 years	–0.087	0.298	0.917	0.512	1.644	0.771
25–29 years	0.134	0.277	1.144	0.664	1.969	0.628
30–34 years	0.021	0.278	1.021	0.592	1.760	0.941
35–39 years	–0.169	0.296	0.845	0.472	1.510	0.569
40+ years (ref.)						
Population of the settlement						0.000**
Up to 1,000 inhabitants	0.050	0.265	1.051	0.625	1.767	0.852
1,001–4,999 inhabitants	0.527	0.214	1.693	1.114	2.575	0.014
5,000–19,999 inhabitants	1.227	0.206	3.410	2.275	5.110	0.000
20,000–49,999 inhabitants	0.516	0.253	1.676	1.021	2.750	0.041
50,000–1,000,000 inhabitants	0.145	0.247	1.156	0.712	1.878	0.558
Budapest (ref.)						
Educational attainment						0.000**
Up to 8 years of primary schooling	0.649	0.193	1.913	1.309	2.795	0.001
Vocational training	0.593	0.181	1.810	1.270	2.579	0.001
Secondary education	–0.109	0.151	0.897	0.667	1.206	0.471
Higher education (ref.)				1.041	1.760	
Employment status						
Unemployed	0.302	0.134	1.353	1.041	1.760	0.024*
Employed (ref.)						
Parity						
First child of the mother	0.075	0.116	1.077	0.858	1.353	0.522
Not the first child (ref.)						
Constant	–3.679	0.335	0.025			0.000 **

Notes: Abbreviations: OR – odds ratio, CI – confidence interval; ref. – reference category. Significance levels: * $p < 0.05$, ** $p < 0.001$.

Source: Cohort '18 Hungarian Birth Cohort Study, prenatal wave, authors' own calculations.

Table 6: Logistic regression to determine factors associated with sport activity during pregnancy – initial model

	B	*S.E.*	*OR*	CI 95%		*p*
Equivalent income quintiles						0.000**
1 (lowest)	–0.776	0.206	0.460	0.308	0.689	0.000
2	–0.789	0.171	0.454	0.325	0.635	0.000
3	–0.693	0.144	0.500	0.377	0.664	0.000
4	–0.415	0.122	0.660	0.519	0.839	0.001
5 (highest; ref.)						
Maternal age						0.601
14–19 years	0.030	0.404	1.031	0.466	2.277	0.941
20–24 years	–0.096	0.272	0.909	0.533	1.549	0.725
25–29 years	–0.124	0.225	0.884	0.569	1.373	0.583
30–34 years	–0.126	0.218	0.881	0.575	1.350	0.561
35–39 years	0.095	0.226	1.099	0.706	1.713	0.676
40+ years (ref.)						
Population of the settlement						0.007*
Up to 1,000 inhabitants	–0.420	0.225	0.657	0.423	1.021	0.062
1,001–4,999 inhabitants	–0.432	0.153	0.649	0.481	0.876	0.005
5,000–19,999 inhabitants	0.006	0.140	1.006	0.765	1.325	0.964
20,000–49,999 inhabitants	0.132	0.165	1.141	0.826	1.578	0.424
50,000–1,000,000 inhabitants	–0.127	0.145	0.881	0.663	1.170	0.381
Budapest (ref.)						
Educational attainment						0.000**
Up to 8 years of primary schooling	–1.043	0.245	0.352	0.218	0.570	0.000
Vocational training	–1.484	0.254	0.227	0.138	0.373	0.000
Secondary education	–0.775	0.116	0.461	0.367	0.578	0.000
Higher education (ref.)						
Employment status						
Unemployed	–0.170	0.174	0.843	0.599	1.187	0.328
Employed (ref.)						
Parity						
First child of the mother	0.648	0.104	1.912	1.599	2.344	0.000**
Not the first child (ref.)						
Constant	–1.328	0.226	0.265			0.000**

Notes: Abbreviations: OR – odds ratio, CI – confidence interval; ref. – reference category. Significance levels: * $p < 0.05$, ** $p < 0.001$.

Source: Cohort '18 Hungarian Birth Cohort Study, prenatal wave, authors' own calculations.

In the models for walking and cycling, the inclusion of depression and anxiety symptoms did not make a difference. Distress symptoms of the respondents did not significantly affect these two types of PA during pregnancy. However, in case of sports, distress was significantly associated with the outcome variable, even after controlling for perceived health and for the need for extra pregnancy care. Therefore, we present only the latter model. The model values are detailed in *Table 7*.

Table 7: Logistic regression to determine factors associated with sport activity during pregnancy – final model

	B	*S.E.*	*OR*	CI 95%		*p*
Equivalent income quintiles						0.000**
1 (lowest)	−0.682	0.215	0.506	0.332	0.770	0.001
2	−0.721	0.179	0.486	0.342	0.690	0.000
3	−0.680	0.151	0.506	0.376	0.681	0.000
4	−0.380	0.128	0.684	0.532	0.879	0.003
5 (highest; ref.)						
Maternal age						0.249
14–19 years	−0.028	0.430	0.972	0.419	2.258	0.948
20–24 years	−0.088	0.293	0.916	0.515	1.627	0.764
25–29 years	−0.180	0.246	0.835	0.515	1.354	0.465
30–34 years	−0.191	0.239	0.826	0.517	1.320	0.425
35–39 years	0.132	0.244	1.141	0.707	1.841	0.589
40+ years (ref.)						
Population of the settlement						0.046*
Up to 1,000 inhabitants	−0.433	0.235	0.648	0.409	1.028	0.066
1,001–4,999 inhabitants	−0.385	0.158	0.680	0.499	0.928	0.015
5,000–19,999 inhabitants	−0.068	0.147	0.935	0.701	1.245	0.644
20,000–49,999 inhabitants	0.106	0.173	1.112	0.793	1.559	0.540
50,000–1,000,000 inhabitants	−0.184	0.153	0.832	0.617	1.122	0.228
Budapest (ref.)						
Educational attainment						0.000**
Up to 8 years of primary schooling	−1.020	0.257	0.360	0.218	0.597	0.000
Vocational training	−1.439	0.262	0.237	0.142	0.397	0.000
Secondary education	−0.766	0.121	0.465	0.367	0.589	0.000
Higher education (ref.)						
Employment status						
Unemployed	−0.123	0.179	0.884	0.622	1.256	0.492
Employed (ref.)						
Parity						
First child of the mother	0.638	0.109	1.892	1.528	2.343	0.000**
Not the first child (ref.)						
Distress						0.020*
Sine morbo (ref.)						
Depression symptoms only	−0.419	0.227	0.658	0.422	1.026	0.065
Anxiety symptoms only	−0.335	0.224	0.715	0.461	1.110	0.136
Comorbidity	−0.642	0.278	0.526	0.305	0.908	0.021
Self-perceived health						0.155
Very good	0.049	1.242	1.050	0.092	11.979	0.818
Good	0.008	1.240	1.008	0.089	11.461	0.061
Fair	0.330	1.245	1.390	0.121	15.948	0.264
Poor	−0.751	1.422	0.472	0.029	7.668	0.980
Very poor (ref.)						
Need for extra pregnancy care						
No need for extra care (ref.)						
Need for extra care	−0.166	0.105	0.847	0.689	1.041	0.114
Constant	−2.159	0.046				0.000**

Notes: Abbreviations: OR – odds ratio, CI – confidence interval; ref. – reference category. Significance levels: * p < 0.05, ** p < 0.001. *Source*: Cohort '18 Hungarian Birth Cohort Study, prenatal wave, authors' own calculations.

This final model for sport activity during pregnancy was statistically significant ($-2LL = 2965.189$; $\chi^2(26) = 366.954$; $p < 0.001$). The explanatory variables explained 7–14% of the variance ($R^2 = 0.07$ (Cox and Snell), 0.14 (Nagelkerke)). In addition to income level, educational attainment, parity, population of the settlement, and distress were also significantly related to sport activity during pregnancy.

DISCUSSION

This study aimed to explore the PA patterns of pregnant women in Hungary in a representative sample and to assess whether physical inactivity during pregnancy is associated with socio-demographic background and maternal mental health.

The findings indicated that the lowest inactivity rate (defined as less than 1 hour of activity per week) before pregnancy was for walking, at 33%. Contrastingly, the inactivity rate was higher for cycling (73%) and for sports (68%).

In comparison, a general population study identified a 70% inactivity rate in the Hungarian adult population (Hungarian Central Statistical Office, 2019). However, it is crucial to note that the reference interval in that particular study was 150 minutes of PA per week, whereas the present study employed a more permissive interval of 60 minutes. The determination of the lower threshold value in this research was justified by the fact that, based on the original four categories (none; less than one hour per week; at least one hour but less than 3 hours per week; at least 3 hours per week), we could not separate 150 minutes of weekly exercise frequency according to the international recommendation. In addition, the low physical activity rate of Hungarian mothers justified the more permissive 60-minute threshold, similar to the study by Gjestland et al. (2013) in Norway. For the aforementioned categorization reasons, the original four categories have been converted into two categories along the 60-minute per week physical activity limit.

Physical inactivity during pregnancy showed a significant increase across all three categories of PA from pre-pregnancy to the third trimester, in line with the consistent trend identified in previous studies documenting an increase in inactivity during pregnancy (Borodulin et al., 2008; Morton et al., 2010; Nascimento et al., 2015), especially in the third trimester (Downs et al., 2012; Padmapriya et al., 2015; Ruifrok et al., 2014). Walking was identified as the most prevalent form of PA during pregnancy, with 59% of mothers walking at least

1 hour a week. Notably, the surge in inactivity during pregnancy was more pronounced for the other two forms of PA, with an outstanding inactivity rate of 92% for cycling and 90% for sports among mothers.

It is noteworthy that no large-sample representative study of PA during pregnancy has been conducted in Hungary prior to this investigation. When compared to international findings, a Chinese study also identified walking as the most common form of PA (Zhou et al., 2022). A cross-sectional study also identified walking as the most common form of exercise during pregnancy, with an observed inactivity rate of 87% in the third trimester (Domingues & Barros, 2007). Similar trends were noted in the United States, where inactivity in late pregnancy was reported at 88% (Ruifrok et al., 2014), while in China the inactivity rate was 89% (Zhang et al., 2014).

In Spain, the prevalence of inactivity during the second trimester was 80% (Amezcua-Prieto et al., 2011). The prevalence of inactivity among pregnant women in Hungary is similarly high, particularly in the case of vigorous physical activities such as playing sports or cycling. It is important to note that the reference value in the aforementioned research was the ACOG-recommended 150 minutes of weekly PA. The present study set the reference value at 60 minutes, thus the inactivity of pregnant women in Hungary is considered to be higher. In the aforementioned Norwegian study, 60 minutes of PA were also measured in the second trimester, with the results showing an 86% inactivity rate (Gjestland et al., 2013).

A number of factors may contribute to the high inactivity rate during the third trimester. Pregnant women may place greater emphasis on rest during pregnancy, especially in the last trimester. In their study, Clark and Gross (2004) interviewed mothers about PA during pregnancy. Mothers mentioned the importance of rest and fear of miscarriage or pregnancy complications as reasons for inactivity. Apart from these factors, inactivity may be caused by mothers' malaise, such as fatigue or nausea (Duncombe et al., 2009; Ribeiro & Milanez, 2011). A further reason for inactivity may be a lack of information received during the antenatal care process about the recommended amount and form of PA during pregnancy and its positive effects (Clarke & Gross, 2004). A study by Nascimento and colleagues (2015) found that only 47% of women received instructions on PA during the antenatal care process.

The results of our study indicated that maternal mental health is associated with physical inactivity. However, this association was only significant for sport as a form of vigorous PA. Compared with mothers with no distress symptoms, those with comorbid symptoms were 0.5 times less likely to be engaged in

sport activity. Mental health was not a significant predictor of walking and cycling inactivity during pregnancy. Sánchez-Polán and colleagues (2021) found that mothers who were inactive during pregnancy were more likely to experience perinatal depression. He et al. (2023) highlighted the beneficial effect of PA on perinatal depression. The study also drew attention to the intensity of PA. Similarly, we also found that only intense forms of PA, such as doing sports, were positively associated with mental health during pregnancy. Previous studies showed that aerobic exercise was associated with a reduced risk of depressive symptoms during pregnancy (Koniak-Griffin, 1994; Robledo-Colonia et al., 2012). Several studies have highlighted the importance of differentiating between the form and intensity of PA, revealing that low intensity activities, such as housework, was associated with higher anxiety (Gebregziabher et al., 2019; Kaur et al., 2019; Syed Nor et al., 2022; Takahasi et al., 2013).

In line with the findings of our study, many studies have not explicitly addressed the proportion of time spent on leisure activities within the overall spectrum of physical activities. Notably, this study encountered challenges in separating walking and cycling as activities for transport purposes from those undertaken for leisure. However, the results of this paper align with the observation that only a lack of sport activities emerged as a predictor of mental health problems. Furthermore, the measurement specifically focused on intense PA as a leisure pursuit, which reinforces previous research showing an association between intense leisure-time PA and mental health during pregnancy.

The socio-demographic characteristics of mothers were found to be predictors of inactivity during pregnancy. Overall, socio-demographic variables explained sport activity to the greatest extent.

For walking and sport, maternal education, income status, population of settlement and parity were associated with physical inactivity. Pregnant women without a university degree were 0.2–0.5 times less likely to engage in sports, while 0.7–0.9 times less likely to walk actively, compared to mothers with a degree. Lower household income was also associated with inactivity during the third trimester. Compared with respondents with the highest income, those in the lowest two quintiles were 0.8 times less likely to walk actively and 0.5 times less likely to be active in sports. For sport activity, the third (0.5 times) and fourth (0.7 times) quintiles were also at risk. These results were consistent with previous research that found that higher maternal education and higher household income were associated with more frequent PA during

pregnancy (Fell et al., 2009; Larrañaga et al., 2013; Nascimento et al., 2015; Petersen et al., 2005).

Regarding the size of the settlement, people living in smaller settlements were more inactive. Compared to those living in Budapest, pregnant women in settlements with less than 50,000 inhabitants were 0.4–0.6 times less likely to walk actively, and the odds were 0.8 times lower in larger cities. Sport activity was reduced by 0.7 times in settlements with 1,000–5,000 inhabitants.

Another significant factor was primiparity. Women who were pregnant with their first child were 0.8 times less likely to walk actively, but 1.9 times more likely to be active in sports. Our results align with previous research in which multiparity has been identified as a predictor of inactivity (Davenport et al., 2018; Gaston & Cramp, 2011). The main possible explanation is the responsibility of caring for older children. Multiparous women engage in a variety of activities with their children, including visits to playgrounds, play, and walks. While these activities may contribute to an increase in overall walking time, they may leave mothers with less time available for more vigorous exercise.

However, in the case of cycling, education, occupational status, and size of settlement showed a different pattern. The odds of being active in cycling were 1.8–1.9 times higher for mothers with the lowest two levels of education (compared to those with a university degree) and 1.4 times higher for unemployed mothers. In addition, active cycling was 1.7–3.4 times more common in settlements with 1–50 thousand inhabitants than in Budapest, and was the most common (*OR* = 3.4) in settlements with 5–20 thousand inhabitants. The results therefore suggested that cycling is a distinct form of PA among pregnant women in Hungary. We concluded that cycling is more likely to be considered as a means of transportation for mothers in the analysis, which is more typical of mothers with lower education and living in small and medium-sized settlements where public transportation options are limited. Moreover, cycling is still a less popular form of transportation in large cities in Hungary than in other European urban areas. Broberg et al. (2015) identified a much higher prevalence of cycling among pregnant women in Denmark. This suggests cultural differences in bicycle use (Oosterhuis, 2016). Therefore, we consider it necessary to analyse the correlates of cycling for leisure purposes in future analyses and to examine the different forms of PA separately.

Our analysis revealed that maternal age was not a significant predictor of either form of PA during pregnancy. Our results are not consistent with the majority of previous findings. Alghamdi (2023) conducted structural interviews with a small number of participants, where maternal age emerged as a

significant predictor of physical activity during pregnancy. Similarly, Fell (2009) identified maternal age as a predictor in his large sample cohort study, whereby younger mothers were more likely to stop exercising during pregnancy. Gebregziabher and colleagues (2019) identified a higher likelihood of inactivity among mothers under 19 years of age. However, a Swedish study found similar results to ours, where the predictive power of maternal age on physical activity during pregnancy was not confirmed. However, there was a positive relationship between maternal age and sedentary time (Meander et al., 2021).

LIMITATIONS AND STRENGTHS

A fundamental limitation of this study is the reliance on self-reported data for the measurement of PA. We did not use a minute-based measurement, thereby precluding the adherence to the international recommendation of 150 minutes of PA per week. Instead, we determined a cut-off point of 1 hour based on a 4-point scale, a more permissive criterion than the international recommendation. While some studies have also adopted a 60-minute threshold for inactivity, in alignment with their respective national recommendations, it is important to acknowledge that the broad interpretability of the results may be constrained.

A further limitation of our analysis pertains to the method employed for identifying mental health problems. The survey used short screening tools, which had no diagnostic validity. Furthermore, the administration of the survey at a single point in time during the third trimester limits a comprehensive understanding of mental health dynamics throughout the entirety of the pregnancy.

We did not investigate the specifics of pregnancy histories, potential complications or symptoms experienced during pregnancy, such as nausea, fatigue, and limb pain, which can affect both PA and mental health. Despite these limitations, a notable strength of our study lies in its use of nationally representative data, allowing for the generalization of our results to a broader context.

CONCLUSION

Considering the acknowledged limitations, our study provides insight into the rates of third trimester physical inactivity among pregnant women in Hungary, using representative data. Furthermore, it elucidates the association of inactivity with socio-demographic background and mental health.

It is important to raise awareness about PA in antenatal care, especially among the at-risk populations. Health education should be expanded in the antenatal care process to highlight the importance of PA during pregnancy, especially for low-income, low-educated primigravida mothers. It is also recommended to emphasize the benefits of vigorous PA for mothers with depressive or anxiety symptoms, considering its positive impact on mental health. In light of our findings, we recommend that professionals involved in antenatal care prioritise the promotion of more intensive PA for pregnant women, especially those with depressive and anxiety symptoms. A range of more intense exercises recommended during pregnancy is thoroughly detailed in the ACOG (2023) recommendation.

REFERENCES

Alghamdi, W. (2023). Socio-demographic predictors of knowledge, attitude and practice of antenatal exercise among pregnant women. *Medical Science*, *27*(132), 1–9. https://doi.org/10.54905/disssi/v27i132/e92ms2886

American College of Obstetricians and Gynecologists. (2020). Physical activity and exercise during pregnancy and the postpartum period: ACOG committee opinion, Number 804. *Obstetrics & Gynecology*, *135*(4), e178–e188. https://doi.org/10.1097/AOG.0000000000003772

American Psychiatric Association. (2013). *Diagnostic and statistical manual of mental disorders* (Fifth Edition). American Psychiatric Association. https://doi.org/10.1176/appi.books.9780890425596

Amezcua-Prieto, C., Lardelli-Claret, P., Olmedo-Requena, R., Mozas-Moreno, J., Bueno-Cavanillas, A., & Jiménez-Moleón, J. J. (2011). Compliance with leisure-time physical activity recommendations in pregnant women: Compliance to physical activity in pregnancy. *Acta Obstetricia et Gynecologica Scandinavica*, no-no. https://doi.org/10.1111/j.1600-0412.2010.01050.x

Bíró, É., & Tokaji, K. (Eds.). (2018). *Európai lakossági egészségfelmérés, Magyarország, 2014*. Központi Statisztikai Hivatal.

Borodulin, K. M., Evenson, K. R., Wen, F., Herring, A. H., & Benson, A. M. (2008). Physical activity patterns during pregnancy. *Medicine & Science in Sports & Exercise*, *40*(11), 1901–1908. https://doi.org/10.1249/MSS.0b013e31817f1957

Bracke, P. F., Levecque, K., & Velde, S. V. de. (2008). *The psychometric properties of the CES-D 8 depression inventory and the estimation of cross-national differences in the true prevalence of depression.* Ghent University.

Broberg, L., Ersbøll, A. S., Backhausen, M. G., Damm, P., Tabor, A., & Hegaard, H. K. (2015). Compliance with national recommendations for exercise during early pregnancy in a Danish cohort. *BMC Pregnancy and Childbirth*, *15*(1), 317. https://doi.org/10.1186/s12884-015-0756-0

Buhling, K. J., Henrich, W., Starr, E., Lubke, M., Bertram, S., Siebert, G., & Dudenhausen, J. W. (2003). Risk for gestational diabetes and hypertension for women with twin pregnancy compared to singleton pregnancy. *Archives of Gynecology and Obstetrics*, *269*(1), 33–36. https://doi.org/10.1007/s00404-003-0483-z

Clarke, P. E., & Gross, H. (2004). Women's behaviour, beliefs and information sources about physical exercise in pregnancy. *Midwifery*, *20*(2), 133–141. https://doi.org/10.1016/j.midw.2003.11.003

Coates, A. O., Schaefer, C. A., & Alexander, J. L. (2004). Detection of postpartum depression and anxiety in a large health plan. *The Journal of Behavioral Health Services & Research*, *31*(2), 117–133. https://doi.org/10.1007/BF02287376

Conn, V. S. (2010). Depressive symptom outcomes of physical activity interventions: Meta-analysis findings. *Annals of Behavioral Medicine*, *39*(2), 128–138. https://doi.org/10.1007/s12160-010-9172-x

Dagher, R. K., Bruckheim, H. E., Colpe, L. J., Edwards, E., & White, D. B. (2021). Perinatal depression: Challenges and opportunities. *Journal of Women's Health*, *30*(2), 154–159. https://doi.org/10.1089/jwh.2020.8862

Daley, A., Foster, L., Long, G., Palmer, C., Robinson, O., Walmsley, H., & Ward, R. (2015). The effectiveness of exercise for the prevention and treatment of antenatal depression: Systematic review with meta-analysis. *BJOG: An International Journal of Obstetrics & Gynaecology*, *122*(1), 57–62. https://doi.org/10.1111/1471-0528.12909

Davenport, M. H., McCurdy, A. P., Mottola, M. F., Skow, R. J., Meah, V. L., Poitras, V. J., Jaramillo Garcia, A., Gray, C. E., Barrowman, N., Riske, L., Sobierajski, F., James, M., Nagpal, T., Marchand, A.-A., Nuspl, M., Slater, L. G., Barakat, R., Adamo, K. B., Davies, G. A., & Ruchat, S.-M. (2018). Impact of prenatal exercise on both prenatal and postnatal anxiety and depressive symptoms: A systematic review and meta-analysis. *British Journal of Sports Medicine*, *52*(21), 1376–1385. https://doi.org/10.1136/bjsports-2018-099697

Dinas, P. C., Koutedakis, Y., & Flouris, A. D. (2011). Effects of exercise and physical activity on depression. *Irish Journal of Medical Science*, *180*(2), 319–325. https://doi.org/10.1007/s11845-010-0633-9

Ding, X.-X., Wu, Y.-L., Xu, S.-J., Zhu, R.-P., Jia, X.-M., Zhang, S.-F., Huang, K., Zhu, P., Hao, J.-H., & Tao, F.-B. (2014). Maternal anxiety during pregnancy and adverse birth outcomes: A systematic review and meta-analysis of prospective cohort studies. *Journal of Affective Disorders*, *159*, 103–110. https://doi.org/10.1016/j.jad.2014.02.027

Dipla, K., Zafeiridis, A., Mintziori, G., Boutou, A. K., Goulis, D. G., & Hackney, A. C. (2021). Exercise as a therapeutic intervention in gestational diabetes mellitus. *Endocrines*, *2*(2), 65–78. https://doi.org/10.3390/endocrines2020007

Domingues, M. R., & Barros, A. J. D. (2007). Leisure-time physical activity during pregnancy in the 2004 Pelotas Birth Cohort Study. *Revista de Saúde Pública*, *41*(2), 173–180. https://doi.org/10.1590/S0034-89102007000200002

Downs, D. S., Chasan-Taber, L., Evenson, K. R., Leiferman, J., & Yeo, S. (2012). Physical activity and pregnancy: Past and present evidence and future recommendations. *Research Quarterly for Exercise and Sport*, *83*(4), 485–502. https://doi.org/10.1080/02701367.2012.10599138

Duncombe, D., Wertheim, E. H., Skouteris, H., Paxton, S. J., & Kelly, L. (2009). Factors related to exercise over the course of pregnancy including women's beliefs about the safety of exercise during pregnancy. *Midwifery*, *25*(4), 430–438. https://doi.org/10.1016/j.midw.2007.03.002

Fell, D. B., Joseph, K. S., Armson, B. A., & Dodds, L. (2009). The impact of pregnancy on physical activity level. *Maternal and Child Health Journal*, *13*(5), 597–603. https://doi.org/10.1007/s10995-008-0404-7

Gaston, A., & Cramp, A. (2011). Exercise during pregnancy: A review of patterns and determinants. *Journal of Science and Medicine in Sport*, *14*(4), 299–305. https://doi.org/10.1016/j.jsams.2011.02.006

Gebregziabher, D., Berhe, H., Kassa, M., & Berhanie, E. (2019). Level of physical activity and associated factors during pregnancy among women who gave birth in Public Zonal

Hospitals of Tigray. *BMC Research Notes*, *12*(1), 454. https://doi.org/10.1186/s13104-019-4496-5

Gjestland, K., Bø, K., Owe, K. M., & Eberhard-Gran, M. (2013). Do pregnant women follow exercise guidelines? Prevalence data among 3482 women, and prediction of low-back pain, pelvic girdle pain and depression. *British Journal of Sports Medicine*, *47*(8), 515–520. https://doi.org/10.1136/bjsports-2012-091344

Goodwin, R. D. (2003). Association between physical activity and mental disorders among adults in the United States. *Preventive Medicine*, *36*(6), 698–703. https://doi.org/10.1016/S0091-7435(03)00042-2

He, L., Soh, K. L., Huang, F., Khaza'ai, H., Geok, S. K., Vorasiha, P., Chen, A., & Ma, J. (2023). The impact of physical activity intervention on perinatal depression: A systematic review and meta-analysis. *Journal of Affective Disorders*, *321*, 304–319. https://doi.org/10.1016/j.jad.2022.10.026

Hungarian Central Statistical Office. (2019). *Az Európai lakossági egészségfelmérések. Sporttevékenység, testmozgás 2019.* (https://www.ksh.hu/elef/kiadvanyok.html) [Xlsx]. https://www.ksh.hu/elef/docs/elef09-19_09.xlsx

Kaur, S., Ng, C. M., Badon, S. E., Jalil, R. A., Maykanathan, D., Yim, H. S., & Jan Mohamed, H. J. (2019). Risk factors for low birth weight among rural and urban Malaysian women. *BMC Public Health*, *19*(S4), 539. https://doi.org/10.1186/s12889-019-6864-4

Koniak-Griffin, D. (1994). Aerobic exercise, psychological well-being, and physical discomforts during adolescent pregnancy. *Research in Nursing & Health*, *17*(4), 253–263. https://doi.org/10.1002/nur.4770170404

Kopcsó, K. (2020). A várandósság alatti depresszió és szorongás szocio-demográfiai rizikótényezői. *Demográfia*, *63*(2–3), 171–197. https://doi.org/10.21543/Dem.63.2-3.2

Kroenke, K., Spitzer, R. L., Williams, J. B. W., Monahan, P. O., & Löwe, B. (2007). Anxiety disorders in primary care: Prevalence, impairment, comorbidity, and detection. *Annals of Internal Medicine*, *146*(5), 317. https://doi.org/10.7326/0003-4819-146-5-200703060-00004

Langan, R., & Goodbred, A. J. (2016). Identification and management of peripartum depression. *American Family Physician*, *93*(10), 852–858.

Laredo-Aguilera, J. A., Gallardo-Bravo, M., Rabanales-Sotos, J. A., Cobo-Cuenca, A. I., & Carmona-Torres, J. M. (2020). Physical activity programs during pregnancy are effective for the control of gestational diabetes mellitus. *International Journal of Environmental Research and Public Health*, *17*(17), 6151. https://doi.org/10.3390/ijerph17176151

Larrañaga, I., Santa-Marina, L., Begiristain, H., Machón, M., Vrijheid, M., Casas, M., Tardón, A., Fernández-Somoano, A., Llop, S., Rodriguez-Bernal, C. L., & Fernandez, M. F. (2013). Socio-economic inequalities in health, habits and self-care during pregnancy in Spain. *Maternal and Child Health Journal*, *17*(7), 1315–1324. https://doi.org/10.1007/s10995-012-1134-4

Magro-Malosso, E. R., Saccone, G., Di Tommaso, M., Roman, A., & Berghella, V. (2017). Exercise during pregnancy and risk of gestational hypertensive disorders: A systematic review and meta-analysis. *Acta Obstetricia et Gynecologica Scandinavica*, *96*(8), 921–931. https://doi.org/10.1111/aogs.13151

Meander, L., Lindqvist, M., Mogren, I., Sandlund, J., West, C. E., & Domellöf, M. (2021). Physical activity and sedentary time during pregnancy and associations with maternal and fetal health outcomes: An epidemiological study. *BMC Pregnancy and Childbirth*, *21*(1), 166. https://doi.org/10.1186/s12884-021-03627-6

Meltzer-Brody, S., & Stuebe, A. (2014). The long-term psychiatric and medical prognosis of perinatal mental illness. *Best Practice & Research Clinical Obstetrics & Gynaecology*, *28*(1), 49–60. https://doi.org/10.1016/j.bpobgyn.2013.08.009

Mortazavi, S. S., Mohammad, K., Ardebili, H. E., Beni, R. D., Mahmoodi, M., & Keshteli, A. H. (2012). Mental disorder prevention and physical activity in Iranian elderly. *International Journal of Preventive Medicine*, *3*(Suppl 1), S64-72.

Morton, S., M. B., Atatoa Carr, P. E., Bandara, D. K., Grant, C. C., Ivory, V. C., Kingi, T. K. R., Liang, R., Perese, L. M., Peterson, E., Pryor, J. E., Reese, E., Robinson, E. M., Schmidt, J. M., & Waldie, K. E. (2010). *Growing up in New Zealand: A longitudinal study of New Zealand children and their families, report 1: before we are born*. Growing Up In New Zealand.

Mottola, M. F., Davenport, M. H., Ruchat, S.-M., Davies, G. A., Poitras, V. J., Gray, C. E., Jaramillo Garcia, A., Barrowman, N., Adamo, K. B., Duggan, M., Barakat, R., Chilibeck, P., Fleming, K., Forte, M., Korolnek, J., Nagpal, T., Slater, L. G., Stirling, D., & Zehr, L. (2018). 2019 Canadian guideline for physical activity throughout pregnancy. *British Journal of Sports Medicine*, *52*(21), 1339–1346. https://doi.org/10.1136/bjsports-2018-100056

Mudd, L. M., Owe, K. M., Mottola, M. F., & Pivarnik, J. M. (2013). Health benefits of physical activity during pregnancy: An international perspective. *Medicine & Science in Sports & Exercise*, *45*(2), 268–277. https://doi.org/10.1249/MSS.0b013e31826cebcb

Nascimento, S. L., Surita, F. G., & Cecatti, J. G. (2012). Physical exercise during pregnancy: A systematic review. *Current Opinion in Obstetrics & Gynecology*, *24*(6), 387–394. https://doi.org/10.1097/GCO.0b013e328359f131

National Institute for Health and Care Excellence. (2014). *Antenatal and postnatal mental health: Clinical management and service guidance*. https://www.nice.org.uk/guidance/cg192

Nguyen, M. T., & Ouzounian, J. G. (2021). Evaluation and management of fetal macrosomia. *Obstetrics and Gynecology Clinics of North America*, *48*(2), 387–399. https://doi.org/10.1016/j.ogc.2021.02.008

Oosterhuis, H. (2016). Cycling, modernity and national culture. *Social History*, *41*(3), 233–248. https://doi.org/10.1080/03071022.2016.1180897

Padmapriya, N., Shen, L., Soh, S.-E., Shen, Z., Kwek, K., Godfrey, K. M., Gluckman, P. D., Chong, Y.-S., Saw, S.-M., & Müller-Riemenschneider, F. (2015). Physical activity and sedentary behavior patterns before and during pregnancy in a multi-ethnic sample of Asian women in Singapore. *Maternal and Child Health Journal*, *19*(11), 2523–2535. https://doi.org/10.1007/s10995-015-1773-3

Peters, T. M., & Brazeau, A.-S. (2019). Exercise in pregnant women with diabetes. *Current Diabetes Reports*, *19*(9), 80. https://doi.org/10.1007/s11892-019-1204-8

Petersen, A. M., Leet, T. L., & Brownson, R. C. (2005). Correlates of physical activity among pregnant women in the United States. *Medicine & Science in Sports & Exercise*, *37*(10), 1748–1753. https://doi.org/10.1249/01.mss.0000181302.97948.90

Poudevigne, M. S., & O'Connor, P. J. (2006). A review of physical activity patterns in pregnant women and their relationship to psychological health. *Sports Medicine*, *36*(1), 19–38. https://doi.org/10.2165/00007256-200636010-00003

Radloff, L. S. (1977). The CES-D scale: A self-report depression scale for research in the general population. *Applied Psychological Measurement*, *1*(3), 385–401. https://doi.org/10.1177/014662167700100306

Ribeiro, C. P., & Milanez, H. (2011). Knowledge, attitude and practice of women in Campinas, São Paulo, Brazil with respect to physical exercise in pregnancy: A descriptive study. *Reproductive Health*, *8*(1), 31. https://doi.org/10.1186/1742-4755-8-31

Robledo-Colonia, A. F., Sandoval-Restrepo, N., Mosquera-Valderrama, Y. F., Escobar-Hurtado, C., & Ramírez-Vélez, R. (2012). Aerobic exercise training during pregnancy reduces depressive symptoms in nulliparous women: A randomised trial. *Journal of Physiotherapy*, *58*(1), 9–15. https://doi.org/10.1016/S1836-9553(12)70067-X

Rubertsson, C., Hellström, J., Cross, M., & Sydsjö, G. (2014). Anxiety in early pregnancy: Prevalence and contributing factors. *Archives of Women's Mental Health*, *17*(3), 221–228. https://doi.org/10.1007/s00737-013-0409-0

Ruchat, S.-M., Mottola, M. F., Skow, R. J., Nagpal, T. S., Meah, V. L., James, M., Riske, L., Sobierajski, F., Kathol, A. J., Marchand, A.-A., Nuspl, M., Weeks, A., Gray, C. E., Poitras, V. J., Jaramillo Garcia, A., Barrowman, N., Slater, L. G., Adamo, K. B., Davies, G. A., … Davenport, M. H. (2018). Effectiveness of exercise interventions in the prevention of excessive gestational weight gain and postpartum weight retention: A systematic review and meta-analysis. *British Journal of Sports Medicine*, *52*(21), 1347–1356. https://doi.org/10.1136/bjsports-2018-099399

Sánchez-Polán, M., Franco, E., Silva-José, C., Gil-Ares, J., Pérez-Tejero, J., Barakat, R., & Refoyo, I. (2021). Exercise during pregnancy and prenatal depression: A systematic review and meta-analysis. *Frontiers in Physiology*, *12*, 640024. https://doi.org/10.3389/fphys.2021.640024

Saxena, S., Van Ommeren, M., Tang, K. C., & Armstrong, T. P. (2005). Mental health benefits of physical activity. *Journal of Mental Health*, *14*(5), 445–451. https://doi.org/10.1080/09638230500270776

Singh, B., Olds, T., Curtis, R., Dumuid, D., Virgara, R., Watson, A., Szeto, K., O'Connor, E., Ferguson, T., Eglitis, E., Miatke, A., Simpson, C. E., & Maher, C. (2023). Effectiveness of physical activity interventions for improving depression, anxiety and distress: An overview of systematic reviews. *British Journal of Sports Medicine*, *57*(18), 1203–1209. https://doi.org/10.1136/bjsports-2022-106195

Slomian, J., Honvo, G., Emonts, P., Reginster, J.-Y., & Bruyère, O. (2019). Consequences of maternal postpartum depression: A systematic review of maternal and infant outcomes. *Women's Health*, *15*, 174550651984404. https://doi.org/10.1177/1745506519844044

Soma-Pillay, P., Nelson-Piercy, C., Tolppanen, H., & Mebazaa, A. (2016). Physiological changes in pregnancy. *Cardiovascular Journal of Africa*, *27*(2), 89–94. https://doi.org/10.5830/CVJA-2016-021

Syed Nor, S. F., Idris, I. B., & Md Isa, Z. (2022). Physical inactivity in early pregnancy and the determinants in an urban city setting of Kuala Lumpur, Malaysia. *BMC Public Health*, *22*(1), 93. https://doi.org/10.1186/s12889-022-12513-5

Szabó, L. (Ed.). (2021). *Growing up in Hungary: Cohort '18 Hungarian Birth Cohort Study: Technical report 2. Preenatal wave* (Working Paper No. 38). Hungarian Demographic Research Institute. https://doi.org/10.21543/WP.2021.38

Szeifert, L. (2010). *Depresszió és életminőség krónikus veseelégtelenségben szenvedő betegek körében*. [Doctoral dissertation, Semmelweis University]. https://doktori.hu/index.php?menuid=193&lang=HU&vid=5717

Takahasi, E. H. M., Alves, M. T. S. S. D. B., Alves, G. S., Silva, A. A. M. D., Batista, R. F. L., Simões, V. M. F., Del-Ben, C. M., & Barbieri, M. A. (2013). Mental health and physical inactivity during pregnancy: A cross-sectional study nested in the BRISA cohort study. *Cadernos de Saúde Pública*, *29*(8), 1583–1594. https://doi.org/10.1590/S0102-311X2013001200011

Truijens, S. E. M., Spek, V., Van Son, M. J. M., Guid Oei, S., & Pop, V. J. M. (2017). Different patterns of depressive symptoms during pregnancy. *Archives of Women's Mental Health*, *20*(4), 539–546. https://doi.org/10.1007/s00737-017-0738-5

Underwood, L., Waldie, K., D'Souza, S., Peterson, E. R., & Morton, S. (2016). A review of longitudinal studies on antenatal and postnatal depression. *Archives of Women's Mental Health*, *19*(5), 711–720. https://doi.org/10.1007/s00737-016-0629-1

Veroszta, Z. (Ed.). (2018). *Technical report: Growing up in Hungary: Cohort '18 Hungarian birth cohort study: Prenatal research, preparational phase* (Working Paper No. 30). Hungarian Demographic Research Institute. https://doi.org/10.21543/WP.2018.30

Veroszta, Z. (Ed.). (2019). *Conceptual framework: Growing up in Hungary - Cohort '18: Hungarian birth cohort study* (Working Paper No. 32). Hungarian Demographic Research Institute. https://doi.org/10.21543/WP.2019.32

Waters, C. S., Hay, D. F., Simmonds, J. R., & Van Goozen, S. H. M. (2014). Antenatal depression and children's developmental outcomes: Potential mechanisms and treatment options. *European Child & Adolescent Psychiatry*, *23*(10), 957–971. https://doi.org/10.1007/s00787-014-0582-3

Watson, E. D., Brage, S., White, T., Westgate, K., Norris, S. A., Van Poppel, M. N. M., & Micklesfield, L. K. (2018). The influence of objectively measured physical activity during pregnancy on maternal and birth outcomes in urban black South African women. *Maternal and Child Health Journal*, *22*(8), 1190–1199. https://doi.org/10.1007/s10995-018-2504-3

Weinstock, M. (2005). The potential influence of maternal stress hormones on development and mental health of the offspring. *Brain, Behavior, and Immunity*, *19*(4), 296–308. https://doi.org/10.1016/j.bbi.2004.09.006

Witvrouwen, I., Mannaerts, D., Van Berendoncks, A. M., Jacquemyn, Y., & Van Craenenbroeck, E. M. (2020). The effect of exercise training during pregnancy to improve

maternal vascular health: Focus on gestational hypertensive disorders. *Frontiers in Physiology*, *11*, 450. https://doi.org/10.3389/fphys.2020.00450

World Health Organization. (2022, October 5). *Physical activity*. https://www.who.int/news-room/fact-sheets/detail/physical-activity

Yeo, S., Steele, N. M., Chang, M. C., Leclaire, S. M., Ronis, D. L., & Hayashi, R. (2000). Effect of exercise on blood pressure in pregnant women with a high risk of gestational hypertensive disorders. *The Journal of Reproductive Medicine*, *45*(4), 293–298.

Zhang, Y., Dong, S., Zuo, J., Hu, X., Zhang, H., & Zhao, Y. (2014). Physical activity aevel of urban pregnant women in Tianjin, China: A cross-sectional study. *PLoS ONE*, *9*(10), e109624. https://doi.org/10.1371/journal.pone.0109624

Zhou, T., Lin, Y., Xu, F., Ma, X., Wang, N., & Ding, Y. (2022). Factors influencing physical inactivity status among Chinese pregnant women: A cross-sectional study. *BMC Public Health*, *22*(1), 2310. https://doi.org/10.1186/s12889-022-14757-7