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Mental Health and Somatic Symptoms of Residents in Relation to Landfill Site Proximity

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The Jakuševec landfill is the main landfill for Zagreb, the capital of Croatia. Its proximity to residential areas has sparked protests from residents demanding better waste disposal solutions. Although its closure was planned years ago, it continues to operate due to a lack of alternatives. Over time, it has become a major environmental problem, mainly due to pollution and unpleasant odors. Despite public concern, no study has yet examined the mental health and somatic symptoms of residents living at different distances from the landfill. For this reason, the current study set out to examine this issue. A total of 823 residents of Zagreb (84.4% women) between the ages of 18 and 85 took part in the online study. Participants indicated their place of residence, reported on their mental health based on measures of depression, anxiety, stress and life satisfaction, and on the frequency of somatic symptoms. Participants indicated their place of residence and provided information on the frequency of somatic symptoms, as well as on their mental health using scales assessing life satisfaction, stress, anxiety, and depression. The results of a series of hierarchical regression analyses showed that living near the landfill was associated with reduced life satisfaction and a higher frequency of somatic complaints. These findings underscore the urgent need for the City of Zagreb to develop alternative waste management strategies that prioritize both environmental sustainability and the health and well-being of local residents .

Keywords: landfill, mental health, somatic symptoms, pollution, proximity

The sustainability of land filling systems has become a global concern due to increasing environmental and public health challenges (Rafiq et al., 2015). In this context, the Prudinec/Jakuševec landfill (hereinafter, Jakuševec landfill) serves as a major disposal site for municipal, non-hazardous, and industrial waste from Zagreb, the capital of Croatia, and its surrounding areas. Covering approximately 80 hectares, it is one of the largest regulated landfills in the country and is located in western Zagreb, about 5 km from the city center and roughly 400 meters from the nearest residences in the Jakuševec district (Barčić & Ivančić, 2010). Its proximity to residential areas highlights the potential for environmental exposure and related health risks, making it a relevant case for studies on the public health impacts of landfills.

Waste disposal at this location began in 1965, and by 1995, around 4.5 million cubic meters of waste had been deposited (Barčić & Ivančić, 2010). By 2000, this number grew to 8 million cubic meters (Barčić & Ivančić, 2010). Due to years of neglect, the site has developed into the largest unmanaged landfill in south-eastern Europe (Nakić et al., 2007). Uncontrolled waste disposal caused significant environmental issues, which necessitated extensive remediation completed in late 2003, transforming the site into a regulated sanitary landfill (Barčić & Ivančić, 2010).

Despite its remediation in 2003, the Jakuševec landfill still has a significant environmental impact, particularly on groundwater and air quality. Investigations of the groundwater and aquifer systems in the vicinity of this landfill in 2004 revealed negative effects on groundwater quality and a gradual spread of pollution towards the east (Nakić et al., 2007). Nakić et al. (2007) state that the pumping system, which was put into operation after the landfill was remediated

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in 2003, is not and cannot be a long-term solution. With this remediation approach, the contamination remains trapped under the landfill body. The heavily contaminated soil and groundwater layers directly beneath the landfill were not removed during the remediation process and continue to be an active source of groundwater pollution.

In addition, a considerable impairment of the air quality in the surrounding neighbourhoods was observed. Due to emissions from landfill gas, substances such as hydrogen sulfide, mercaptans, and gaseous fluorides are released, often exposing nearby residents to unpleasant odors and airborne particles. These volatile compound concentrations have been shown to be significantly higher in summer than in winter (Vađić, 2006).

The announcement of the closure of the Jakuševec landfill was made years ago and has since caused resentment among local residents, especially those living in the immediate vicinity of the landfill (Opačak & Wang, 2019). The landfill administration, which is operated by the municipal company ZGOS Ltd., proposed December 31, 2018 as the date for the end of waste disposal (Opačak & Wang, 2019). Despite the intention to close the landfill, it continues to operate due to inadequate regional waste treatment facilities. A solution for the landfill has not yet been found by 2025.

Residents remain frustrated and frequently voice their protests in the media (e.g., Index.hr, 2022; Kronike Velike Gorice, 2022; Jutarnji, 2025), arguing that the landfill harms their health and overall well-being and decreases the value of their property. Despite ongoing public concern, there are still no studies that explore whether living near the landfill is related to the physical or psychological well-being of the local residents.

Review of literature

Prior studies (e.g. Abiola et al., 2021; Heaney et al., 2011; Singh et al., 2020) indicate that residing in the vicinity of landfills is associated with elevated health risks. In their systematic review, Vinti et al. (2021) reported elevated rates of mortality, respiratory illness, and adverse mental health outcomes among residents living in close proximity to landfills. In addition, the research indicated differential exposure to landfill types and showed that residents living near open landfills had far more severe health problems than those living near regulated sanitary landfills (Peprah et al., 2024). For example, Peprah et al. (2024) investigated differences in physical and mental symptoms in residents living next to three landfill sites in Ghana's Ashanti region. The majority of people suffered from health complaints such as insomnia, breathing difficulties, skin rashes and irritations, persistent fatigue, low mood, reduced appetite, stress, anxiety and depression. People living near open landfills show a significantly higher propensity for a range of health symptoms, including reduced appetite, severe fatigue, depression, increased anxiety, mental disorders, decreased mood and cognitive impairment, than people residing in the vicinity of an engineered landfill.

The negative health effects associated with landfills are largely due to the environmental conditions in their vicinity, in particular the constant exposure to toxic fumes and dust (Njoku et al., 2019). As exposure generally decreases with increasing distance from the pollution source (Mataloni et al., 2016), comparisons between residents living near landfills and those living further away provide important insights into how proximity is related to health outcomes.

Although relatively few studies have investigated these differences, those that do exist have generally found significant differences in physical health. As an illustration, Njoku et al., (2019) compared residents living 100–500 m versus 1–2 km from a landfill in South Africa's Limpopo province and reported higher rates of respiratory symptoms and diseases in those living closer to the site. Phan et al. (2021) reported that individuals residing up to 2 km from a waste facility were much more likely to report dermatological complaints and gastrointestinal problems than people living further away.

In addition to physical health, both studies also investigated the effects of proximity to landfill sites on psychological health and overall quality of life, although the results differed. Njoku et al. (2019) have shown that the life satisfaction of people living near landfills is lower than that of people living further away from such sites. Conversely, Phan et al. (2021) pointed out that the psychological health and quality of life score remains relatively low regardless of proximity to waste disposal facilities.

Purpose of the study

Systematic reviews of studies addressing the impact of solid waste management practices on health (e.g., Porta et al., 2009; Vinti et al., 2021) have provided sufficient evidence that living near landfills can negatively affect human health. However, the results of international studies cannot be directly applied to the Jakuševec landfill, as the landfills differ significantly in terms of construction, waste composition, management practises and proximity to residential areas. This highlights the importance of analysing the Jakuševec landfill in its specific local context. Such an analysis

is particularly urgent considering that local residents have repeatedly expressed their concerns about the potential harmful effects of the landfill (e.g., Index.hr, 2022; Kronike Velike Gorice, 2022; Jutarnji list, 2025) and that no comprehensive health studies have been conducted in Croatia to date.

Accordingly, this study seeks to address two key questions. The questions are as follows: (a) Does residential distance from the Jakuševec landfill predict the frequency of somatic symptoms? and (b) Does residential distance from the Jakuševec landfill predict mental health problems manifested as lower life satisfaction and higher levels of stress, anxiety, and depression symptoms?

Unlike the majority of previous studies (e.g., Njoku et al., 2019; Phan et al., 2021), the distance to the landfill was treated as a continuous variable in the present study. Prior work (e.g., Njoku et al., 2019; Phan et al., 2021) typically classifies distance into broad categories (e.g., "near" versus "far"), potentially neglecting more nuanced variations in the effects of landfill residence.

In this study, mental health is assessed on the basis of self-reported stress levels, life satisfaction and the frequency of depressive and anxiety symptoms. We chose to examine the relationship between living distance from the landfill and stress levels, as pollution is considered one of the most important human stressors. As part of the broader stress theory, Environmental Stress Theory explains how environmental factors such as pollution, noise, and overcrowding can cause stress in individuals (Evans, 1984). In this context, environmental stressors are specific challenges that individuals must appraise and respond to. If individuals perceive that environmental demands exceed their coping abilities, stress occurs (Lazarus & Folkman, 1984).

According to Lazarus and Cohen (1977), polution falls into the category of stressor with daily difficulties. Even if such stressors do not have immediate or dramatic effects, their persistent nature can significantly affect morale, social functioning, and overall health. For this reason, we also used life satisfaction as an indicator to recognise how sensitive it is to long-term environmental stress. In addition, we examined symptoms of depression and anxiety based on three key points emphasised by Lazarus and Cohen (1977). First, stress-related emotions - such as anxiety and depressive sadness - have a direct effect on personal satisfaction and morale. Second, these emotions affect a wide range of adaptive functions, including problem-solving ability, social competence, and physical health, and third, their presence reflects a fundamental interaction between the individual and his or her environment.

Another strength of this study is the inclusion of age and socioeconomic status as a control variables when analysing the relationship between proximity to the landfill and somatic symptoms and mental health outcomes. Specifically, we considered respondents' income level and their subjective perception of their standard of living. This approach aligns with prior evidence indicating that socioeconomic status is an important determinant of both mental (e.g., Lei et al., 2024) and somatic health outcomes (e.g., San Sebastian et al., 2015), and allows for a more accurate and nuanced interpretation of the studied relationships.

In addition to all these methodological aspects, this study is characterised by the fact that it is the first study in Croatia to address these issues and thus makes an important contribution to the investigation of the possible effects of the Jakuševec landfill on the health of local residents in Croatia.

Method

Participants

The study sample consisted of 823 individuals (84.4% women) aged 18 to 85 years. In terms of education, 35.6% had completed a master's degree, and 31.6% had finished secondary school. A further 16.3% held a bachelor's degree, 8% had obtained a doctorate, and 7.2% had only an elementary education or less. With respect to marital status, the sample comprised 54.9% married, 33.5% single, 8.1% divorced, and 3.4% widowed individuals. Participants lived in households of an average size of $M = 3.24$ persons ($SD = 1.53$). Approximately two-thirds of participants (67.9%) were employed.

Measures

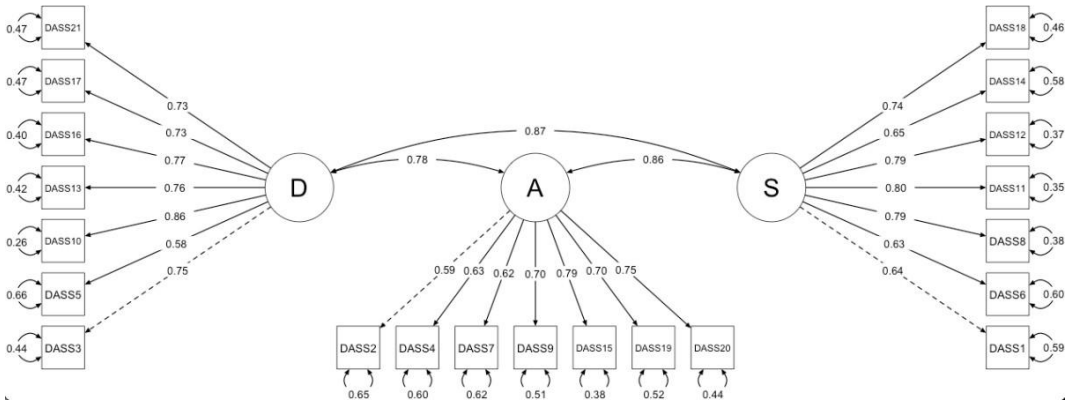
Depression, anxiety, and stress

The DASS-21 (Lovibond & Lovibond, 1995) is the 21-item abbreviated version of the original 42-item scale, consisting of three subscales (7 items each): depression (e.g., "I couldn't seem to experience any positive feeling at all"), anxiety (e.g., "I felt scared without any good reason"), and stress (e.g., "I found it difficult to relax"). Participants assessed the degree to which each item reflected their experience in the past week on a 4-point scale (0 = not at all, 1 =

sometimes, 2 = often, 3 = almost always). Higher scores reflect more severe symptoms, with a theoretical range of 0 to 21 per subscale. To investigate the construct validity of the DASS latent constructs, a first-order, three-factor CFA (Confirmatory Factor Analysis) model was specified for the 21 items of the DASS-21 scale (Supplementary material 1). The model demonstrated acceptable fit to the data ($\chi^2(186) = 1042.62$, $p < .05$; CFI = .913; TLI = .902; RMSEA = .075; SRMR = .048). No additional modifications were made, as the initial model was theoretically consistent and provided a satisfactory fit across all indices. Internal consistency indicators in this study for depression ($\alpha = .89$), anxiety ($\alpha = .86$), and stress ($\alpha = .88$) subscales were excellent, consistent with previous findings (Henry & Crawford, 2005).

Supplementary Material 1

Parameter Estimates for the first-order three-factor CFA model of the DASS scale



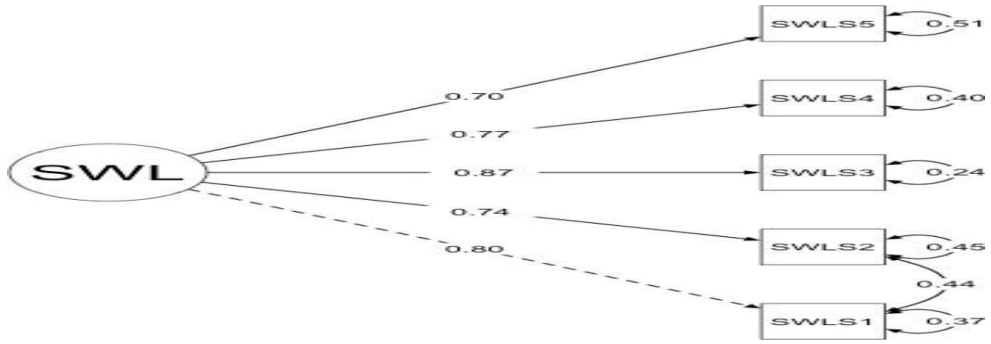
Note. Standardized coefficients are presented. Maximum likelihood estimation with bootstrap standard errors was used. D - Depression, A - Anxiety, S - Stress

Satisfaction with life

The SWLS (Diener et al., 1985; Croatian adaptation by Komšo & Burić, 2016) measures global life satisfaction through 5 items (e.g., "In most ways my life is close to my ideal"). Responses were given on a 7-point scale (1 = strongly disagree to 7 = strongly agree). Possible total scores span from 5 to 35, where higher values indicate higher levels of life satisfaction. A five-item, one-factor CFA model was specified to assess the construct validity of life satisfaction (Supplementary material 2). The initial model demonstrated relatively good fit ($\chi^2(5) = 114.05$, $p < .05$; CFI = .954; TLI = .908; RMSEA = .163; SRMR = .038), although the RMSEA exceeded the recommended threshold. An examination of the modification indices suggested that adding the residual covariance between item 1 ("In most ways my life is close to my ideal") and item 2 ("The conditions of my life are excellent") would substantially improve model fit, likely due to their conceptual overlap ("close to ideal" vs. "excellent conditions"). After allowing this covariance, the model fit improved considerably ($\chi^2(4) = 49.01$, $p < .05$; CFI = .990; TLI = .970; RMSEA = .100; SRMR = .020). All standardized factor loadings were high, supporting strong relationships between each indicator and the latent life satisfaction construct. Cronbach's alpha indicated good internal consistency in this sample ($\alpha = .89$).

Supplementary Material 2

Parameter Estimates for the one-factor CFA model of the SWLS scale



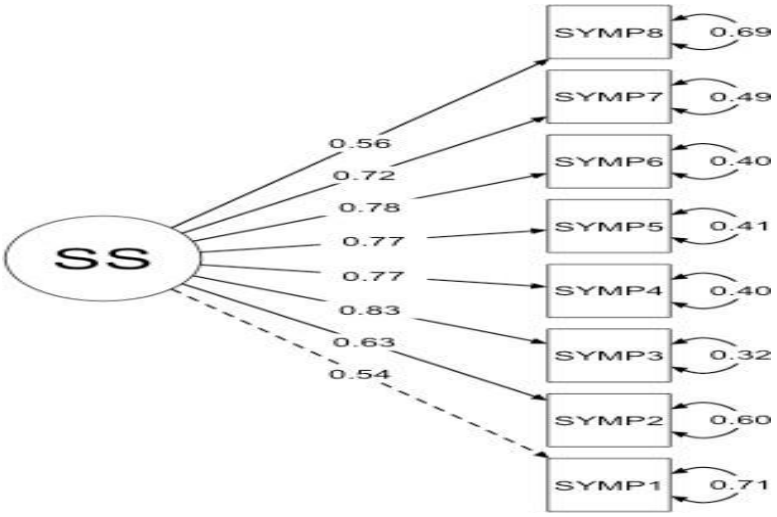
Note. Standardized coefficients are presented. Maximum likelihood estimation with bootstrap standard errors was used. SWL - satisfaction with life

Somatic symptoms

The Symptom subscale of the Air Quality Perception Scale (Deguen et al., 2012) assesses the frequency of eight perceived physical symptoms associated with air pollution (e.g., "Did you experience nasal irritation?"). Items were rated on a 4-point scale (0 = never, 1 = rarely, 2 = often, 3 = always). The possible score range is 0–24, where higher scores correspond to a greater perceived frequency of symptoms. To assess the construct validity of the Symptom Subscale, an eight-item, one-factor CFA model was specified (Supplementary material 3). The model demonstrated good overall fit ($\chi^2(20) = 152.52$, $p < .01$; CFI = .956; TLI = .938; RMSEA = .090; SRMR = .032). No additional modifications were applied, as the model showed satisfactory fit and aligned with the theoretical structure of the subscale. Although the RMSEA slightly exceeded the commonly suggested cut-off value of .08 for acceptable fit (Hu & Bentler, 1999), it is worth noting that elevated RMSEA values can occur in simpler models with small degrees of freedom (Kenny et al., 2015)., and the strong CFI and SRMR values indicated acceptable overall model fit. The internal consistency was $\alpha = .88$ (original study $\alpha = .73$).

Supplementary Material 3

Parameter Estimates for the one-factor CFA model of the Symptom subscale of the Air Quality Perception Scale



Note. Standardized coefficients are presented. Maximum likelihood estimation with bootstrap standard errors was used. SS - somatic symptoms.

Socioeconomic status

Socioeconomic status was assessed using two indicators. The first was self-reported monthly household income, measured on an 8-point scale (1 = up to €600, 2 = €601–860, 3 = €861–1,130, 4 = €1,131–1,660, 5 = €1,661–2,190, 6 = €2,191–2,720, 7 = €2,721–3,250, 8 = over €3,250). The second indicator measured the standard of living

perceived by the participants, which was rated on a 5-point scale (1 = well below average, 2 = below average, 3 = average, 4 = above average, 5 = well above average).

Distance from the landfill

The distance between the participants' homes and the Jakuševec landfill was measured in kilometers using Google Maps. The airline distance from the landfill to individual neighborhoods in Zagreb and Zagreb County was recorded.

Procedure

Prior to data collection, the study protocol underwent review and received approval from the Ethics Committee of the Catholic University of Croatia. The data was collected in May 2024 using an online questionnaire created with LimeSurvey. The survey link was shared through social media platforms, including Facebook, Instagram, LinkedIn, and WhatsApp. Participants provided informed consent and were notified about the study's purpose, the voluntary nature of their involvement, and the guarantees of anonymity and confidentiality. Participants could withdraw at any time. The questionnaire took about 10 minutes to complete.

Data Analysis

To assess the construct validity of the measures used, confirmatory factor analyses were performed with the *lavaan* (Rosseel, 2012), *semPlot* (Epskamp, 2015) and *semptools* (Cheung & Lai, 2025) packages in R (R Core Team, 2023). As the chi-square statistic tends to over reject models in large samples (Kline, 2015), model adequacy was assessed using several goodness-of-fit indices (CFI, TLI, RMSEA, SRMR) using the thresholds recommended by Hu and Bentler (1999). To investigate the predictive contribution of landfill proximity beyond age and two indicators of socioeconomic status (SES) on mental health and somatic symptoms, five hierarchical regression analyses were performed using SPSS (version 23). Age and SES were entered at Step 1 as covariates, and distance to landfill was added in step 2. Outcomes included mental health (depression, anxiety, stress, life satisfaction) and somatic symptoms.

Results

Descriptive statistics and intercorrelations

Descriptive statistics and Pearson intercorrelations for all study variables are shown in Table 1. Participants reported an average income of $M = 5.48$ ($SD = 1.97$) on an 8-point scale and an average standard of living of 3.02 ($SD = 0.70$) on a 5-point scale, both of which are values around the centre of the scale. The distance to the landfill ($M =$ 6.12 km, $SD = 3.59$) showed considerable variability (range = 1.08–20.18 km).

Table 1

Descriptive Statistics and Intercorrelations Among Study Variables

Variable	*M*	*SD*	1	2	3	4	5	6	7	8	9
1. Age	41.22	13.03									
2. Income	5.48	1.97	−.15**								
3. Life standard	3.02	0.70	−.15**	.47**							
4. Symptoms	6.50	4.70	.08*	−.16**	−.21**						
5. Depression	4.44	3.98	.03	−.19**	−.21**	.36**					
6. Anxiety	3.50	3.75	−.03	−.17**	−.21**	.50**	.69**				
7. Stress	6.14	3.98	−.05	−.12**	−.16**	.38**	.79**	.74**			
8. Satisfaction	22.28	6.45	−.21**	.28**	.44**	−.32**	−.52**	−.38**	−.41**		
9. Distance	6.12	3.59	−.10**	.02	.00	−.17**	−.02	−.06	−.03	.12**	

Note. $N = 823$. *$p < .05$, **$p < .01$. Distance - distance from landfill in km, Satisfaction - Life satisfaction, Symptoms – Somatic symptoms

The average depression ($M = 4.44$, $SD = 3.98$), anxiety ($M = 3.50$, $SD = 3.75$), and stress ($M = 6.14$, $SD =$ 3.98) scores were all below the theoretical scale midpoint (10.5), indicating generally low levels of reported psychological distress. Life satisfaction ($M = 22.28$, $SD = 6.45$) was slightly above the scale midpoint, reflecting moderately high satisfaction. Somatic symptom scores ($M = 6.50$, $SD = 4.70$) fell below the theoretical midpoint of the scale, suggesting low to moderate levels of reported somatic complaints.

Income and subjective life standard were strongly positively correlated ($r = .47$, $p < .01$), indicating that individuals with higher household incomes also tended to perceive their standard of living as higher. Both income and

life standard were negatively correlated with all mental health outcomes (depression, anxiety, stress) and somatic symptoms, with correlations ranging from negligible to small in size (income: $r = -.12$ to $-.19$; life standard: $r = -.16$ to $-.21$, all $p < .01$). This suggests that participants with lower SES reported more psychological distress and somatic complaints. Distance from the landfill was weakly but significantly positively correlated with life satisfaction ($r = .12$, $p < .01$) and negatively with somatic symptoms ($r = -.17$, $p < .01$). These results suggest that individuals living further from the landfill tended to report slightly higher life satisfaction and fewer somatic complaints. Intercorrelations between mental health outcomes were strong and positive ($r = .69$ to $.79$, $p < .01$), indicating that these distress indicators tended to co-occur. Life satisfaction was moderately negatively related to depression, anxiety, and stress ($r = -.32$ to $-.52$, $p < .01$), and moderately positively related to income and life standard ($r = .28$ to $.44$, $p < .01$). Somatic symptoms correlated moderately with depression, anxiety, and stress ($r = .36$ to $.50$, $p < .01$), and weakly negatively with life satisfaction ($r = -.32$, $p < .01$), confirming that greater somatic complaints were associated with poorer psychological well-being and lower life satisfaction.

Hierarchical regression analyses

Five hierarchical multiple regression analyses were conducted to examine the predictive contribution of distance to the landfill beyond age and socioeconomic status in explaining mental health and somatic symptoms (Table 2).

Table 2

Hierarchical Regression Analyses Predicting Mental Health and Somatic Symptoms

Outcome	Predictor	Step 1 b	Step 1 β	Step 2 b	Step 2 β	ΔR^2	Final R^2
SS	Age	.02 [−.01, .04]	.04	.01 [−.02, .03]	.02	$.027^{***}$	.076
	Income	−.17 [−.36, .01]	−.07	−.17 [−.35, .01]	−.07		
	Standard	−1.12 [−1.63, −.60]	$-.17^{***}$	−1.14 [−1.64, −.63]	$-.17^{***}$		
	Distance			−.22 [−.31, −.13]	$-.17^{***}$		
Depression	Age	−.01 [−.03, .02]	−.02	−.01 [−.03, .02]	−.02	.00	.055
	Income	−.24 [−.39, −.08]	$-.12^{**}$	−.24 [−.39, −.08]	$-.12^{**}$		
	Standard	−.90 [−1.33, −.47]	$-.16^{***}$	−.90 [−1.34, −.47]	$-.16^{***}$		
	Distance			−.02 [−.10, .05]	−.02		
Anxiety	Age	−.02 [−.04, −.001]	$-.07^{*}$	−.02 [−.04, -.003]	$-.08^{*}$	.004	.059
	Income	−.20 [−.35, −.06]	$-.11^{**}$	−.20 [−.34, −.06]	$-.11^{**}$		
	Standard	−.90 [−1.31, −.49]	$-.17^{***}$	−.90 [−1.31, −.50]	$-.17^{***}$		
	Distance			−.07 [−.14, .002]	−.07		
Stress	Age	−.02 [−.05, −.003]	$-.08^{*}$	−.03 [−.05, −.004]	$-.08^{*}$	.001	.036
	Income	−.13 [−.29, .03]	−.06	−.13 [−.28, .03]	−.06		
	Standard	−.82 [−1.26, −.38]	$-.14^{**}$	−.83 [−1.27, −.39]	$-.15^{**}$		
	Distance			−.04 [−.11, .04]	−.03		
LS	Age	−.07 [−.10, −.04]	$-.14^{***}$	−.06 [−.10, −.03]	$-.13^{***}$	$.011^{**}$	.231
	Income	.27 [.05, .50]	$.08^{*}$	.27 [.04, .49]	$.08^{*}$		
	Standard	3.51 [2.87, 4.15]	$.38^{***}$	3.53 [2.89, 4.16]	$.38^{***}$		
	Distance			.19 [.08, .30]	$.11^{**}$		

Note. $N = 823$. $^{*}p < .05$, $^{**}p < .01$, $^{***}p < .001$. Distance - distance from landfill in km, Standard - life standard, SS - somatic symptoms, LS - life satisfaction. 95% CI of b coefficients are presented in squared brackets

For somatic symptoms, the first model was significant, $F(3, 819) = 13.97$, $p < .001$, and explained 4.9% of the variance ($R^2 = .049$). Lower standard of living was a significant predictor ($\beta = -.17$, $t = -4.27$, $p < .001$) of increased somatic symptoms, in contrast to both age ($\beta = .04$, $t = 1.16$, $p = .245$) and income level ($\beta = -.07$, $t = -1.88$, $p = .061$). Adding distance to the landfill significantly improved the model, $\Delta R^2 = .027$, $F(1, 818) = 24.34$, $p < .001$. Distance was found to be a significant negative predictor ($\beta = -.17$, $t = -4.93$, $p < .001$), with participants who lived near the landfill reporting more somatic symptoms. This is the positive answer to the first research question of the study.

For depression, the first model, which included the age, income and standard of living variables, was significant, $F(3, 819) = 15.90$, $p < .001$, and explained 5.5% of the variance ($R^2 = .055$). Lower income ($\beta = -.12$, $t = -3.04$, $p < .01$) and lower life standard ($\beta = -.16$, $t = -4.08$, $p < .001$) predicted greater depression, while age had no predictive contribution in explaining depression. Adding distance to the landfill in step 2 did not significantly improve the model, $\Delta R^2 = .00$, $F(1, 818) = 0.30$, $p = .549$. Distance was not a significant predictor of depression ($\beta = -.02$, $t = -0.60$, $p = .549$).

For anxiety, the first model was significant, $F(3, 819) = 15.75$, $p < .001$, and explained 5.5% of the variance ($R^2 = .055$). Lower age ($\beta = -.07$, $t = -2.05$, $p = .041$), as well as lower income ($\beta = -.11$, $t = -2.72$, $p = .007$) and lower standard of living ($\beta = -.17$, $t = -4.31$, $p < .001$) predicted greater anxiety. Adding distance to the landfill explained an additional 0.4% of the anxiety variance, and didn't improve the model, $\Delta R^2 = .004$, $F(1, 818) = 3.66$, $p = .056$. Distance was not a significant predictor of anxiety ($\beta = -.07$, $t = -1.91$, $p = .056$).

For stress, the initial model was significant, $F(3, 819) = 9.87$, $p < .001$, and explained 3.5% of the variance ($R^2 = .035$). Lower age ($\beta = -.08$, $t = -2.29$, $p = .022$), as well as lower standard of living ($\beta = -.14$, $t = -3.68$, $p < .01$) predicted higher stress, whereas income did not ($\beta = -.06$, $t = -1.64$, $p = .101$). Adding distance to the landfill did not significantly improve the model, $\Delta R^2 = .001$, $F(1, 818) = 0.88$, $p = .349$. Distance was not a significant predictor of stress ($\beta = -.03$, $t = -0.94$, $p = .349$).

For life satisfaction, the first model was highly significant, $F(3, 819) = 76.77$, $p < .001$, and explained 21.9% of the variance ($R^2 = .219$). Lower age ($\beta = -.14$, $t = -4.46$, $p < .001$, as well as higher income ($\beta = .08$, $t = 2.36$, $p = .019$) and higher standard of living ($\beta = .38$, $t = 10.78$, $p < .001$) predicted greater life satisfaction. Adding distance from the landfill significantly improved the model, $\Delta R^2 = .011$, $F(1, 818) = 11.73$, $p = .001$. Distance was a significant positive predictor ($\beta = .11$, $t = 3.43$, $p = .001$) for life satisfaction, suggesting that participants who lived further away from the landfill reported higher life satisfaction, and conversely, those who lived near the landfill reported lower life satisfaction. These results indicate a partially positive answer to the second research question of the study.

Discussion

The findings of this study indicate that the proximity of the residential area to the Jakuševec landfill is related to the frequency of somatic symptoms, even after controlling for age, income and the participants' assessment of their standard of living. In particular, the data showed that individuals residing nearer to the landfill tended to report more somatic symptoms. These findings align with studies carried out in other countries, e.g. in Bangladesh (Shammi et al., 2023), India (De & Debnath, 2016), Ghana (Peprah et al., 2024), Mexico (Al-Delaimy et al., 2014), South Africa (Njoku et al., 2019), and Paksitan (Akmal & Jamil, 2021). They provide strong empirical evidence that living near landfills is associated with symptoms such as sleep disturbance, fatigue, respiratory problems, loss of appetite and eye irritation. These symptoms have been shown to be related to exposure to environmental stressors — such as unpleasant odours and particulate matter. In one study, Heaney et al. (2011) had participants record odour intensity, changes in daily activities, mood, and somatic symptoms across 14 days, with hydrogen sulphide concentrations in the air being measured every 15 minutes. The results showed a strong correlation between hydrogen sulphide concentration, perceived odour intensity and the presence of somatic symptoms, including nasal irritation, coughing and sneezing.

As far as mental health is concerned, the results of this study showed that distance from the Jakuševec landfill is related to the life satisfaction, even after controlling for age, income and participants' assessment of their standard of living. In particular, the data showed that people living closer to the landfill had lower levels of life satisfaction. The aforementioned study by Njoku et al. (2019) also showed that people living nearby (100–500 m) were more likely to report lower life satisfaction than residents living far (1–2 km) from the landfill. Proximity to landfills may be associated with lower life satisfaction due to a combination of environmental, esthetic and psychosocial stressors. Those living near landfills are not only exposed to unpleasant odors and visual pollution, but also worry about potential health risks. These factors can contribute to a lingering sense of unease, lower levels of housing satisfaction and perceived neglect by local authorities, all of which can have a negative impact on an individual's overall life satisfaction.

This study is not without limitations. The use of a cross-sectional design is a notable limitation, as it restricts the extent to which causal relationships can be inferred. In addition, unmeasured variables — such as the participants' previous health status or psychological characteristics — could have influenced the results and possibly distorted the observed associations. To address these limitations, conducting a longitudinal study would be extremely valuable, as it would make it possible to track changes in residents' mental and physical health over time while measuring air quality. This approach would provide a deeper insight into the effects of prolonged exposure to pollution on health and could help to identify specific points in time or phases when health problems occur or intensify. Future work should also test a partially mediated SEM model in which distance to the landfill predicts life satisfaction indirectly via somatic symptoms and stress, while retaining a direct path from distance to life satisfaction and controlling for age, income, and perceived standard of living. Such a model would estimate the direct path from distance to life satisfaction alongside indirect paths via somatic symptoms and stress, allowing a comparison of how much of the association is mediated

versus direct. Moreover, this study is affected by a frequently noted limitation of Internet-based research, whereby male participants generally have lower participation rates than their female counterparts (Porter & Umbach, 2006). Future research should employ sampling methodologies that better reflect the sex distribution in the country, such as quota sampling. Additionally, a potential limitation of the study is that people who were more concerned about the landfill may have been more likely to participate. This self-selection bias could have influenced the results by overrepresenting individuals with a higher reported frequency of symptoms.

However, despite its limitations, this study has several advantages. For example, this study treated distance to landfill as a continuous variable rather than a categorical variable, which is a methodological advance over most previous studies. This approach allowed for a better understanding of how small differences in proximity can be associated with health indicators and avoids arbitrary dichotomisation that could obscure nuanced patterns in the data. In addition to the methodological aspects, a major strength of this study lies in its novelty. It is the first study in Croatia to specifically examine the relationship between distance to the Jakuševec landfill and the mental health and somatic symptoms of the capital's residents. It fills a significant gap in the national scientific literature and provides an essential basis for future evidence-based policy decisions. The study provides empirical evidence of the potential health risks associated with inappropriate waste management practices and emphasises the need for a different approach to landfill siting and operation.

Conclusion

The results of this study showed that residents of the Jakuševec landfill reported more somatic symptoms, even after controlling for age, income and standard of living. In particular, they reported more frequent headaches, fatigue, eye irritation, breathing difficulties, loss of appetite and sleep problems. In addition, residents living near the landfill reported lower levels of life satisfaction.

These results highlight the importance of understanding and addressing residents' perceptions and health concerns related to the landfill. Municipal authorities should consider measures to improve waste management practices and environmental monitoring to support community well-being.

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