Martens, Karel, and Matan E. Singer. 2024. "A Scale for Describing People's Mobility Status." *Findings*, April. https://doi.org/10.32866/001c.94195.

TRANSPORT FINDINGS

A Scale for Describing People's Mobility Status

Karel Martens[1], Matan E. Singer[2]

[1] Faculty of Architecture and Town Planning, Technion – Israel Institute of Technology, [2] School of Public Health & the Haifa Center on the Politics of Inequality, University of Haifa

Keywords: mobility problems, visual analogue scale, mobility status, travel difficulties, ease of access, survey tool, accessibility

https://doi.org/10.32866/001c.94195

Findings

We introduce and test a visual analogue scale (VAS) to measure to what extent people experience difficulties in reaching destinations (N=180). Known-group analyses showed that respondents who are younger, without vehicle access, or in need of a walking aid, had significantly worse accessibility. Regression analysis with reported mobility problems as dependent variables, showed that VAS replaced car availability as the sole significant explanatory variable. A separate regression model revealed that the mobility problems explain more than half of the variance in VAS (R2=0.528). These results are promising but more research is needed to scrutinize the validity of the VAS.

1. Questions

In this paper we introduce and test a direct scaling method to measure to what extent people experience difficulties in reaching desired or needed destinations. The proposed method is an adaptation of the visual analogue scale (VAS) widely used in health research and practice (Krabbe 2017). In its original form, the VAS consists of a horizontal line of a fixed length, with its end points clearly marked and described, typically being 'death' and 'full health' (Figure 1). Respondents are asked to mark their self-assessed health status somewhere along the horizontal line, so that the VAS method generates a single number indicating a person's health status.

Direct scaling methods like VAS have in common that they convert respondents' judgments directly into numerical scores. They differ from studies relying on a set of questions, which require merging responses to generate one single score for each respondent (Hand 2004). VASs have been criticized on various grounds, such as the lack of an underlying theoretical measurement framework, and respondents' answers being dependent on context and potentially suffering from adaptation bias (Ryan et al. 2001). In spite of these critiques, VASs have been used extensively in health care, in part because of their simplicity and in part because they show reasonably robust results, including moderate-to-good test-retest reliability (Krabbe et al. 2006; Bernert et al. 2009).

In transportation, transport planners and researchers could use a VAS to quickly identify population segments or neighborhoods with high shares of people facing difficulties in reaching destinations, or as part of the evaluation of (large) transport investments.

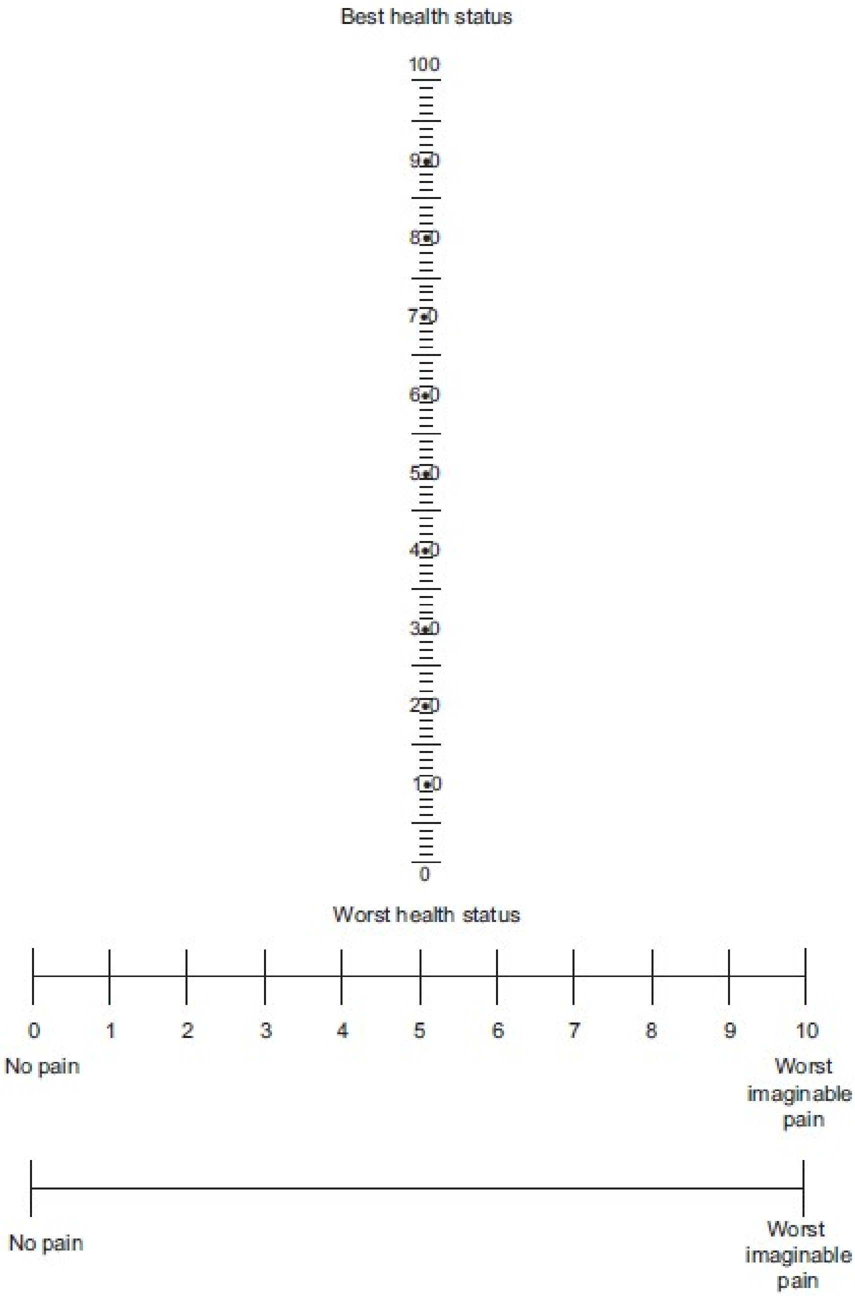

Figure 1. Different examples of visual analogue scales employed in health research (source: Krabbe 2017, p. 80)

To the best of our knowledge, the VAS method has not yet been employed to assess a person's mobility problems (see Skarin et al. 2019 for a different application in transport). Here, we present the results of a small application as part of a large-scale survey.

2. Methods

We report on the results of a survey among 180 respondents from peri-urban settlements in the Tel Aviv metropolitan area. The survey aim was to gain insight into respondents' mobility problems, defined as any difficulty people may experience in reaching desired or needed destinations (Pritchard and Martens 2023; Singer and Martens 2023). The questionnaire distinguished between three types of mobility problems: difficulties encountered while traveling (4 questions); reliance on others for lack of reasonable alternatives (3 questions); and forgoing trips because of an inadequate transport system (5 questions). For each question, respondents were offered four answering categories ranging from no problems to severe problems (see Supplemental Information). For the analyses that follow, respondents' responses for each problem type were also summed into indices and all questions were summed into a composite index.

The VAS question was formulated as follows: "How would you assess your mobility (that is, how easy and quickly can you reach the destinations you want to reach) on a scale from 0 to 10". The end states were defined as "the worst possible mobility state, in which you cannot reach specific destinations because of inadequate transport" and "the best possible mobility state, in which you can reach your destinations without worrying about delays, costs, lack of comfort, physical challenge, etc.". Because of its use in a computer-assisted telephone interview (CATI), we employed a scale of 0-10, with respondents being allowed to only select whole numbers. We refer to the VAS scores as a person's mobility status, in analogy to the term health status used in health studies.

The survey was conducted in the winter of 2020-2021, during the COVID-19 pandemic, but in periods without lockdown limitations.

3. Findings

Respondents' self-assessment of their mobility status was very high, with an average VAS score of 8.5 and a median of 9.0 (Table 1). 77 respondents (43%) reported the best possible score, while only 24 respondents (13%) assessed their mobility status with 6 or lower, including two respondents assessing their mobility status as the worst possible state (Figure 2). Such a skewed distribution is somewhat surprising given the variance of travel problems across a population reported elsewhere, including in the survey area (Murphy, Gould-Werth, and Griffin 2021; Pritchard and Martens 2023). One explanation is the over-representation of higher-income individuals with vehicle access in the sample, in combination with the unique free-flowing traffic circumstances during the pandemic.

To test the validity of the VAS scale, we first conducted known-group analyses. The literature shows that carless households, people on low income, women, youth and elderly, as well as people with various kinds of impairments, are more likely to experience mobility difficulties (Lucas 2012; Murphy, Gould-Werth, and Griffin 2021). The analyses partly confirm this pattern (Table 2). While no significant differences were found between women and men or by income, younger respondents (aged 18-34 years old), respondents without vehicle access, and those using or needing a walking aid had statistically significantly lower mobility status than other groups.

Table 1: Summary Statistics on the Sample

	2020 Census Data	Number of respondents		Self-Reported VAS Scores		
	%	#	%	Median	Mean	Standard Deviation
Full Sample		180		9	8.5	2.0
Sex						
Female	49.3	105	58.3	9	8.4	2.1
Male	50.7	75	41.7	9	8.6	1.9
Age						
18-34	19.2	19	10.6	8	7.2	2.7
35-44	13.8	25	13.9	10	9.2	1.2
45-54	11.5	69	38.3	9	8.4	2.2
55-64	9.0	29	16.1	9	8.9	1.3
65+	14.4	38	21.1	9	8.5	2.1
Income Status						
Below Average		4	2.2	8.5	8.0	2.5
Average		56	31.1	9	8.2	2.4
Above Average		120	66.7	9	8.6	1.9
Car Availability						
Not Available/Borrow		26	14.4	6	5.9	3.2
Sole User/Share		154	85.6	9	8.9	1.4
Walking Aid						
No Need		156	86.7	9	8.7	1.8
Use or Need		24	13.9	8	7.4	2.9
Have children						
No		180	100.0	9	8.5	2.0
Yes		0	0.0			

Note: Additional metropolitan population data were not available for the relevant time period. Census data refer to the population in the Tel Aviv District and Central District, which together compose the Tel Aviv metropolitan area. Sources: Central Bureau of Statistics, retrieved from: https://www.cbs.gov.il/he/publications/doclib/2021/2.shnatonpopulation/st02_19x.pdf

Second, we conducted two sets of regression analyses with the mobility problem indices (trip difficulties, reliance on others, trips forgone, and a composite index integrating all questions) as the dependent variable. The Base models include only socio-economic characteristics, while the VAS models add the VAS score as an independent variable (Table 3). In three of the four VAS models, VAS replaced car availability as the sole significant explanatory variable. Adding the VAS also improved the explanatory power of the models, yet these remained relatively weak (Adjusted R^2 between 0.02-0.17 in the Base models and 0.17-0.24 in the VAS models).

Next, we sought to explain respondents' VAS scores solely based on the mobility problem items. As expected, pairwise comparisons showed that experiencing more frequent travel problems is associated with a lower VAS score. 11 of the 12 mobility problem items were negatively correlated with the

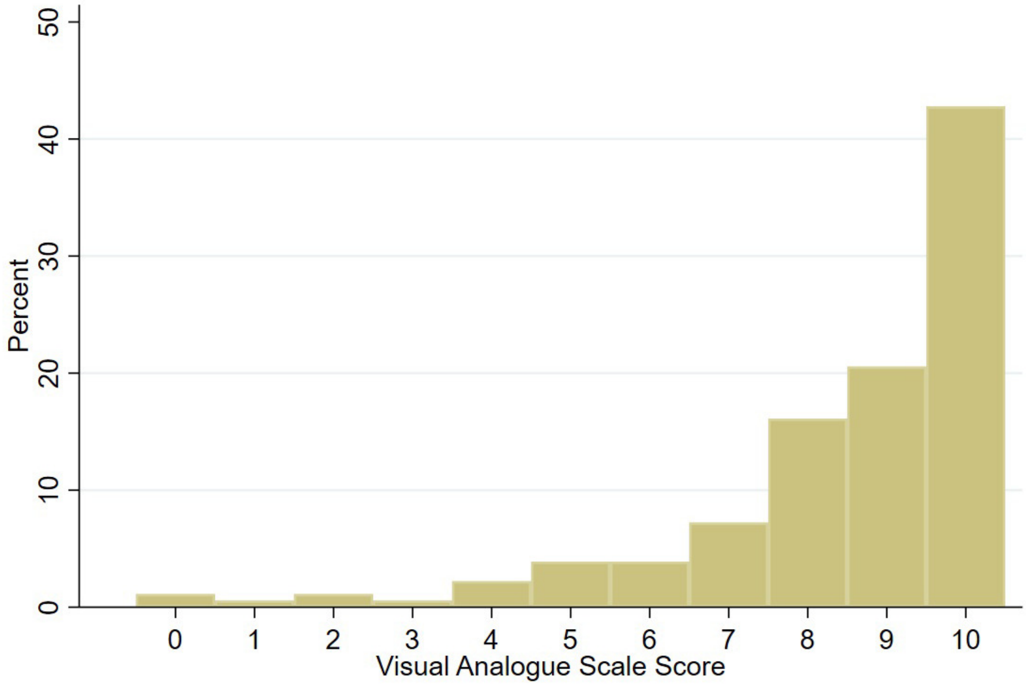

Figure 2. Respondents' Self-Reported VAS Scores (N=180)

VAS scores (Table 4), ranging from -0.22 (relying on family members) to -0.45 (trip difficulties-effort). Correlations were even higher for the four indices, ranging from -0.41 (Reliance) to -0.50 (Composite index).

Finally, we employed an Ordinary Least Squares (OLS) regression with robust standard errors on the VAS scores (log-transformed) using the twelve mobility problem items as explanatory dummy variables (0=two answering categories representing no or few mobility problems; 1=two answering categories representing more severe problems; see Supplemental Information). The model explains more than half of the variance in VAS (R^2=0.528). The variables show the expected (negative) sign (i.e., experiencing more frequent travel problems is associated with a lower VAS), with the exception of Reliance: Family and Others and Trips Forgone: Effort and No Return (Table 4), yet none of the latter were significant.

Taken together, the results show that VAS scores are correlated with reported travel problems, as well as with several expected demographic characteristics. This suggests that a VAS may be successfully employed in transport research to obtain an assessment of the ease with which people can reach destinations. Given the limitations of the sample distribution (e.g., by income, household composition, and residential location), more research is needed to determine whether a VAS delivers valid and reliable results. If successful, the VAS may be employed to assess a person's mobility status in a broad range of studies, including travel behavior surveys, as well as for ex post evaluations of transport interventions.

Table 2: Known-Group Analysis on VAS

A. Two-Group Comparison

	N	VAS	t-statistic
Gender			
Female	105	8.4	0.351
Male	75	8.6	
Vehicle Access			
Not Available/Borrow	26	5.9	-8.227***
Sole User/Share	154	8.9	
Walking Aid			
Use or Needed	24	7.4	2.918***
No Need of walking assistance	156	8.7	

B. Analysis of Variance (t-statistics)

Income Status	N	VAS	Below Average	Average
Below Average	4	8.0		
Average	56	8.2	0.214	
Above Average	120	8.6	0.625	0.411

Age	N	VAS	18-34	35-44	45-54	55-64
18-34	19	7.2				
35-44	25	9.2	2.002**			
45-54	69	8.4	1.248	-.754		
55-64	29	8.9	1.739**	-.264	.491	
65+	38	8.5	1.368	-.634	.121	-.370

Notes: *** p<0.01, ** p<0.05, * p<0.1.

Acknowledgements

The authors would like to thank Gali Freund for her contribution in designing the survey and for her initial analyses of the collected data set within the framework of her master thesis research. The telephone survey was carried out by the Geocartography Knowledge Group, based in Tel Aviv, Israel.

Submitted: January 04, 2024 AEST, Accepted: February 21, 2024 AEST

Table 3: Ordinary Least Squares Regressions on Travel Problem Indices

Variables	Difficulties Index Base Model Coefficient (SD)	Difficulties Index VAS Model Coefficient (SD)	Reliance Index Base Model Coefficient (SD)	Reliance Index VAS Model Coefficient (SD)	Forgone Index Base Model Coefficient (SD)	Forgone Index VAS Model Coefficient (SD)	Composite Index Base Model Coefficient (SD)	Composite Index VAS Model Coefficient (SD)
Sex								
Female	0.659 (2.93)	1.814 (2.69)	0.624 (2.53)	1.170 (2.48)	1.162 (2.31)	2.072 (2.12)	0.235 (0.47)	0.410 (0.73)
Age (Reference: 18-34)								
35-44	-3.894 (5.80)	3.264 (5.45)	-16.727*** (5.00)	-13.345*** (5.02)	-0.221 (4.58)	5.422 (4.31)	-1.622* (0.92)	-0.534 (0.87)
45-54	-6.032 (4.87)	-0.944 (4.55)	-14.599*** (4.20)	-12.195*** (4.19)	-3.710 (3.85)	0.301 (3.59)	-1.957** (0.77)	-1.184 (0.73)
55-64	-5.247 (5.61)	-0.643 (5.19)	-13.103*** (4.84)	-10.928** (4.78)	-1.022 (4.43)	2.607 (4.10)	-1.420 (0.89)	-0.721 (0.83)
65+	-7.491 (5.31)	-2.760 (4.93)	-11.209** (4.58)	-8.974** (4.54)	-3.601 (4.19)	0.129 (3.89)	-1.614* (0.84)	-0.896 (0.79)
Income status (Reference: Average)								
Below Average	-0.251 (9.98)	8.507 (9.26)	-16.171* (8.61)	-12.034 (8.53)	-9.384 (7.88)	-2.480 (7.31)	-2.791* (1.58)	-1.461 (1.48)
Above Average	0.085 (3.11)	-0.033 (2.85)	1.997 (2.68)	1.942 (2.62)	-3.023 (2.46)	-3.116 (2.25)	-0.217 (0.49)	-0.235 (0.46)
Car Availability								
Not Available/Borrow	13.191*** (4.27)	-1.775 (4.68)	18.771*** (3.69)	11.700*** (4.31)	8.117** (3.38)	-3.681 (3.70)	2.995*** (0.68)	0.722 (0.75)
Walking Aid								
Use or Need	1.874 (4.18)	-4.637 (3.99)	1.186 (3.61)	-1.890 (3.68)	2.671 (3.30)	-2.462 (3.15)	0.373 (0.66)	-0.616 (0.64)
Visual Analogue Scale		-4.624*** (0.80)		-2.185*** (0.73)		-3.645*** (0.63)		-0.702*** (0.13)
Constant	15.281*** (5.00)	52.062*** (7.81)	17.142*** (4.32)	34.520*** (7.20)	9.803** (3.95)	38.799*** (6.17)	9.965*** (0.79)	15.552*** (1.25)
Observations	180	180	180	180	180	180	180	180
F	1.61	5.11	5.11	5.7	1.3	4.76	3.45	6.68
Prob > F	0.1151	0.0000	0.0000	0.0000	0.2392	0.0000	0.0006	0.0000
R^2	0.079	0.232	0.213	0.252	0.065	0.220	0.154	0.283
Adjusted R^2	0.030	0.187	0.171	0.208	0.015	0.174	0.110	0.241

Notes: *** p<0.01, ** p<0.05, * p<0.1. SD – Standard Deviation.

Table 4: Explaining VAS using Travel Problem Items: Pairwise Correlations and Ordinary Least Squares Regression on the Visual Analogue Scale

Variables	**Pairwise Correlations**	**OLS** Coefficient (SD)
Difficulties: Time	-0.295***	-0.145** (0.07)
Difficulties: Effort	-0.451***	-0.308** (0.13)
Difficulties: Cost	-0.341***	-0.042 (0.08)
Difficulties: Discomfort	-0.298***	-0.044 (0.10)
Reliance: Family	-0.215***	0.030 (0.09)
Reliance: Friends	-0.425***	-0.609*** (0.20)
Reliance: Others	-0.341***	0.077 (0.30)
Trips Forgone: Time	-0.438***	-0.030 (0.13)
Trips Forgone: Effort	-0.324***	0.063 (0.15)
Trips Forgone: Cost	-0.333***	-0.477** (0.18)
Trips Forgone: Discomfort	-0.356***	-0.133 (0.15)
Trips Forgone: No Return	-0.115	0.136 (0.23)
Constant		2.211*** (0.02)
Observations		178
F		11.48
Prob > F		0.000
R^2		0.528

Notes: *** p<0.01, ** p<0.05, * p<0.1. SD – Standard Deviation.

REFERENCES

Bernert, Sebastian, Ana Fernández, Josep Maria Haro, Hans-Helmut König, Jordi Alonso, Gemma Vilagut, Christine Sevilla-Dedieu, et al. 2009. "Comparison of Different Valuation Methods for Population Health Status Measured by the EQ-5D in Three European Countries." *Value in Health* 12 (5): 750–58. https://doi.org/10.1111/j.1524-4733.2009.00509.x.

Hand, D.J. 2004. *Measurement Theory and Practice: The World through Quantification*. London: Arnold.

Krabbe, Paul F.M. 2017. *The Measurement of Health and Health Status: Concepts, Methods and Applications from a Multidisciplinary Perspective*. Academic Press.

Krabbe, Paul F.M., Peep F.M. Stalmeier, Leida M. Lamers, and Jan J.V. Busschbach. 2006. "Testing the Interval-Level Measurement Property of Multi-Item Visual Analogue Scales." *Quality of Life Research* 15 (10): 1651–61. https://doi.org/10.1007/s11136-006-0027-7.

Lucas, Karen. 2012. "Transport and Social Exclusion: Where Are We Now?" *Transport Policy* 20 (March): 105–13. https://doi.org/10.1016/j.tranpol.2012.01.013.

Murphy, A.K., A. Gould-Werth, and J. Griffin. 2021. "Validating the Sixteen-Item Transportation Security Index in a Nationally Representative Sample: A Confirmatory Factor Analysis." *Survey Practice* 14 (1): 27185.

Pritchard, John P., and Karel Martens. 2023. "Towards Systematic Measurement of Travel Problems: A Pilot Study in the Greater Tel Aviv Area." *Travel Behaviour and Society* 32 (July): 100591. https://doi.org/10.1016/j.tbs.2023.100591.

Ryan, M., D. A. Scott, C. Reeves, A. Bate, E. R. van Teijlingen, E. M. Russell, M. Napper, and C. M. Robb. 2001. "Eliciting Public Preferences for Healthcare: A Systematic Review of Techniques." *Health Technology Assessment* 5 (5): 1–186. https://doi.org/10.3310/hta5050.

Singer, Matan E., and Karel Martens. 2023. "Measuring Travel Problems: Testing a Novel Survey Tool in a Natural Experiment." *Transportation Research Part D: Transport and Environment* 121 (August): 103834. https://doi.org/10.1016/j.trd.2023.103834.

Skarin, Frida, Lars E. Olsson, Margareta Friman, and Erik Wästlund. 2019. "Importance of Motives, Self-Efficacy, Social Support and Satisfaction with Travel for Behavior Change during Travel Intervention Programs." *Transportation Research Part F: Traffic Psychology and Behaviour* 62 (April): 451–58. https://doi.org/10.1016/j.trf.2019.02.002.

SUPPLEMENTARY MATERIALS

Supplemental Information

Download: https://findingspress.org/article/94195-a-scale-for-describing-people-s-mobility-status/attachment/196995.pdf