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Exploring individuals’ well-being visiting urban and peri-urban green areas: a quantile regression approach

Antonio Tomao^{a*}, Luca Secondi^a, Piermaria Corona^b, Giuseppe Carrus^c,
Mariagrazia Agrimi^a

^aDepartment for Innovation in Biological, Agro-food and Forest systems, University of Tuscia, Viterbo, Italy

^bConsiglio per la ricerca in agricoltura e l'analisi dell'economia agraria, Forestry Research Centre (CREA-SEL) Arezzo, Italy

^cDepartment of Education, Experimental Psychology Laboratory, Roma Tre University, Rome, Italy

Abstract

Environmental conditions affect the individuals’ quality of life as well as physical, psychological and social well-being. Green areas play a key role in improving well-being perceived by the citizens in urban contexts. The direct and indirect experience with nature helps to reduce psychophysical stress, induces positive emotions, and facilitates renewal of cognitive resources. An example of this is represented by *Pinus pinea* L. (Italian stone pine) forests located within or around urban areas. These pinewoods were originally diffused in Mediterranean region to produce wood, pine kernels for alimentary purposes and - in coastal areas - to protect dunes and agricultural territories. However, land use change and coastal urbanization modified their principal functions: while productive function has been gradually reduced, they become important elements of the urban landscape contributing to human well-being with a wide range of cultural services. With increasing interest in the use of urban green space to promote human health, it is interesting to analyze if and to what extent different natural settings, as well as restoration components influence well-being by disentangling the effect on physical and psychological benefits. The aim of this paper is to explore the effect of experience variables and restoration components on individuals’ physical and psychological well-being. A quantile regression approach was used for data analysis. This approach allows us to understand what happens throughout the entire distribution of psychological and physical well-being reported by visitors of pinewoods and, in particular, at its extremes. Our results show that the effect of the selected covariates is different both throughout the distribution of the dependent variable and between psychological and physical subjective well-being.

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* Corresponding author.

E-mail address: antonio.tomao@unitus.it

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1. Introduction

Environment and environmental conditions affect human health and individuals' quality of life (EEA 2013). In recent years, much research has been carried out aimed at understanding the relationships between people's subjective well-being and several dimensions of environment such as air quality, climate, local amenities (Rehdanz and Maddison 2005, Brereton et al. 2008, Ferreira et al. 2013) as well as at exploring the role of natural environment (i.e. trees, woodland and green spaces) on physical, psychological and social well-being (O'Brien 2005, O'Brien and Morris 2014, Carrus et al. 2015).

Within this context, green areas play a key role in improving well-being perceived by the citizens in urban context (see for example Peron et al. 2002, Miller 2006, Fuller et al. 2007) since they provide both physical and psychological benefits derived from the direct and indirect experience with nature reducing psychophysical stress, inducing positive emotions and facilitating the renewal of cognitive sources. Benefits can be gained not only by being active in nature (e.g. walking or cycling), but also by viewing nature, for example from a window, or being near it during everyday activities. In addition, green spaces have demonstrated greater capacity, compared with built-up areas, for promoting human health and well-being (e.g. Carrus et al. 2015). An emblematic example is represented by *Pinus pinea* L. (Italian stone pine) forests located within or around urban areas. Reforestations and afforestations by this species were originally established in the Mediterranean region, and then occasionally diffused in other similar climate zones around the world, with the aim of producing wood, seeds for alimentary purposes (pine kernels) and - in coastal areas - to protect dunes and surrounding agricultural territories. However, land use change along coasts gradually modified their principal functions. Indeed, due to coastal urbanization process in many parts of the Mediterranean basin they gradually lost their productive function becoming important elements of the urban landscape and contributing to human well-being with a wide range of cultural services.

With increasing interest in the use of urban green space to promote human health, there is a need to understand the extent to which park users conceptualize these places as a resource for health and well-being. Many studies on psychological restoration in nature provide empirical evidence of stress reduction (e.g., Ulrich et al. 1991) and attention restoration derived from natural settings (e.g., Tennessen and Cimprich 1995, Berman et al. 2008). Yet, it is interesting to understand if and to what extent restoration components - introduced in the study according to the Attention Restoration Theory (ART, Kaplan 1995) - influence individuals' well-being, by disentangling their effect on physical and psychological benefits. Furthermore, since forest structure is one of the most influencing parameters on most ecosystem services (De Groot et al. 2010), it is important to investigate if natural settings characterized by diverse structure can have different effects on well-being perception.

In this perspective, our study aims at contributing to the literature by exploring the effect of the selected set of explicative variables through a quantile regression approach. Indeed, from a policy perspective it is interesting to understand what happens throughout the entire distribution of psychological and physical well-being obtained from pinewoods and at its extremes - instead of focusing on the conditional mean of the dependent variable - in order to plan targeted and effective intervention programs aimed at improving individual and social well-being. Furthermore, we draw attention to the evaluation of differences in well-being outcomes of forests characterized by diverse structural characteristics.

2. Material and methods

2.1 Study area

Italian stone pine forests, because of their history, origin, management and applied forestry can assume different structures. Several different structural types have been identified (Ciancio et al. 1986, Agrimi et al. 2002): e.g. even-aged forest stands; bi-stratified or pluri-stratified forest stands; uneven-aged forest stands. If these structural types coexist in a relatively small area, a "composite" structure can be identified (Zhu et al. 2003, Ciancio et al. 2009, Chirici et al. 2008). Besides, pinewoods can be located along a rural-urban gradient: inside cities boundaries (urban

pinewoods) or in proximity to urban areas (peri-urban pinewoods). Three coastal pine forests with different forest structures (from even aged to composite structure) and location (from urban to peri-urban) were selected as case study (Fig. 1). They are located along Latium coasts in the provinces of Rome and Viterbo.

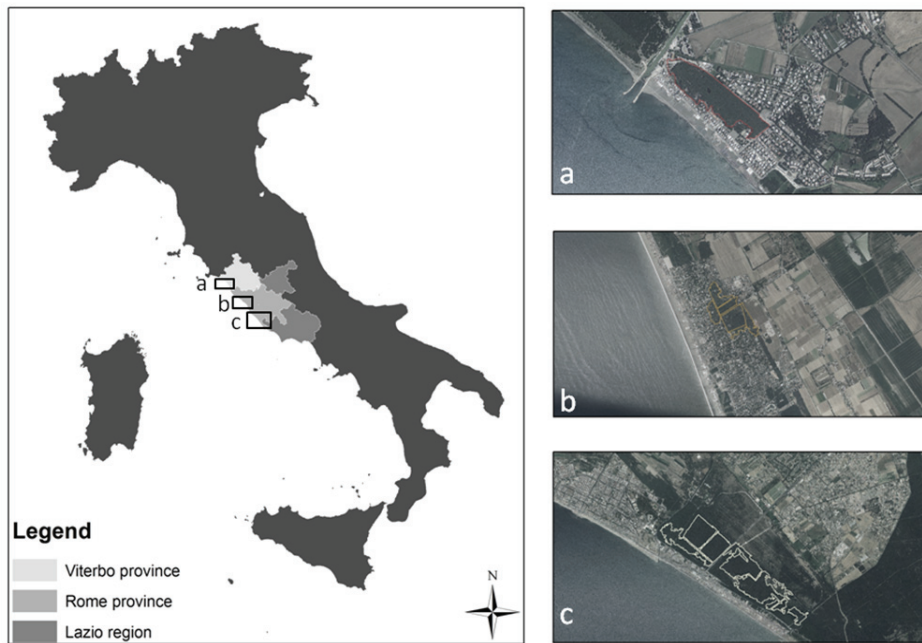


Fig. 1 Location of study areas. a) Montalto Marina pinewood (even-aged urban pinewood); b) Fregene pinewood (even-aged and bi-stratified urban pinewood); c) Castelfusano pinewood (peri-urban pinewood with composite structure)

2.2 Data collection

The aim of our research was to explore if and to what extent restoration components and structural characteristics of pinewoods (e.g. forest stand structure, tree density) influence physical and subjective perceived well-being of individuals visiting pinewoods. Participants were randomly recruited from visitors spending their leisure time at the three selected locations. Our study involved 218 individuals (52% women; mean age = 41.7 years; Standard Deviation - SD = 18.6). We involved 72 (33%) participants visiting the pinewood in Montalto Marina, 77 (35%) the pinewood in Fregene and 69 (32%) the pinewood in Castelfusano.

Each respondent was asked to fill in a questionnaire organized into three sections. The first section included questions concerning demographic data, setting experience (length and frequency of visits, crowding) and activity performed (socialization, walking, contemplation or physical activity) in the site under study. The second section was focused on the perceived *restorativeness*. According to the ART, the regenerative potential of an environment is related to four components: being-away, extent, fascination, and compatibility (Hartig et al. 1997). The restorative properties of the settings were assessed through 4 items taken from the Italian version of the Perceived Restorativeness Scale (PRS; Pasini et al. 2009). In the third section, specific questions aimed at measuring psychological and physical benefits while visiting study site were included.

All variables were measured through a 5-point scale ranging 1 to 5 (see Laforteza et al. 2009, Carrus et al. 2015 for analogous procedures). As far as well-being is concerned, two questions in the survey investigated psychological and physical benefits derived from visiting the pinewood. It is worth noting that the same questionnaire was used in the three pinewoods. Figure 2 shows the distribution of all the responses to the questions “Do you feel psychological

benefits while visiting this place?" (Figure 2a) and "Do you feel physical benefits while visiting this place?" (Figure 2b).

The two distributions of subjective well-being (SWB) are negatively skewed with mean values equal to 3.74 (SD = 0.97) and to 3.45 (SD = 1.02) for psychological and physical well-being, respectively. This distribution confirms the suitability of quantile regression models for analyzing the relationship between visiting of green areas and perceived well-being.

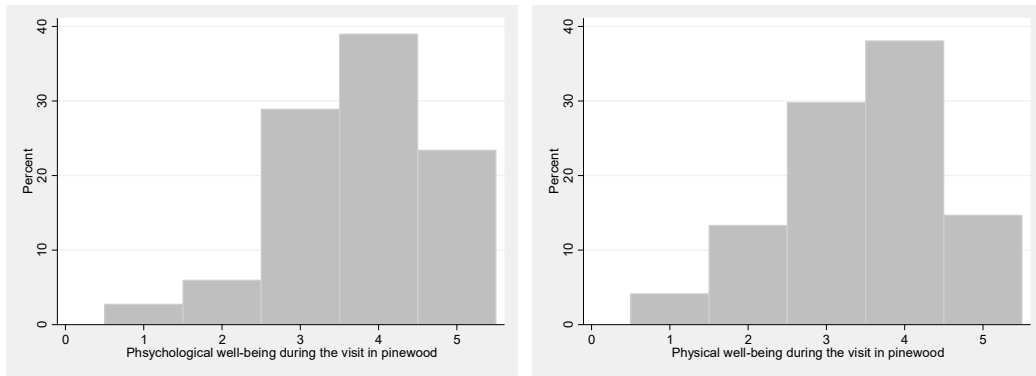


Fig. 2 Perceived benefits from visiting pinewood. a) psychological well-being; b) physical well-being

2.3 Definition and specification of quantile regression models

Quantile regression models have been recently introduced in studies related to subjective well-being and life satisfaction (Binder and Coad 2011; Yuan and Golpewar 2012; Biggeri et al. 2013). Similarly, in the context of our study, the use of quantile regression models can help to obtain a more complete picture of the relationships between natural environment and psychological and physical benefits obtained while visiting pinewoods. Indeed, through quantile regression models we are able to estimate slope parameters that vary at different quantiles of the conditional well-being distributions.

The quantile regression model specifies the conditional quantile of the dependent variable y as a linear function of covariates (Koenker 2005):

$$Q_{\theta}(y_i | \mathbf{x}_i) = \mathbf{x}_i' \boldsymbol{\beta}_{\theta} + \varepsilon_{i\theta} \quad (1)$$

where y_i ($i=1, \dots, n$) is the dependent variable represented, in turn, by psychological and physical level of well-being perceived while visiting pinewood, $\mathbf{x}_i$ is a sequence of k -vector of regressors, $\boldsymbol{\beta}_{\theta}$ is an unknown vector of regression parameters associated with the θ th quantile and $\varepsilon_{i\theta}$ is an unknown error term. According to Koenker and Bassett (1978) who introduced quantile regression models, the θ -th regression quantile, $0 < \theta < 1$, is defined as any solution to the minimization of the sum of absolute deviation residuals:

$$\min_{\boldsymbol{\beta} \in R^k} \left\{ \sum_{i: y_i \geq \mathbf{x}_i' \boldsymbol{\beta}} \theta |y_i - \mathbf{x}_i' \boldsymbol{\beta}| + \sum_{i: y_i < \mathbf{x}_i' \boldsymbol{\beta}} (1 - \theta) |y_i - \mathbf{x}_i' \boldsymbol{\beta}| \right\} \quad (2)$$

which is solved by linear programming methods. When θ is continuously increased from 0 to 1, we obtain the entire conditional distribution of y conditional on $\mathbf{x}$.

Starting from the general equation (1) and with the aim of identifying factors influencing physical and psychological well-being originated from visiting pinewoods, we specified two quantile regression models which

assumed the dependent variable y_i ($i=1,\dots,n$) to be: (i) subjective physical well-being and (ii) psychological well-being while visiting the pinewoods. In both models the k -dimensional vector x_i of covariates includes factors describing the dimension of restorativeness defined according to the ART, experience variables related to the activities performed in the green areas and to the duration and frequency of the visits as well as indicator variables identifying the specific site visited. Finally, a set of socio-demographic characteristics (gender, age, education) are also included in the models as control factors as well as a variable identifying the specific pinewood visited is introduced.

3 Results

3.1. Perceived well-being: psychological and physical benefits

Quantile regression offers the possibility of observing how the effect of the selected covariates change throughout the entire distribution of the dependent variable.

Figures 3 and 4 below provide a graphical view of quantile regression estimates concerning the effect of the four components of perceived restorativeness. In each graph, vertical axes refer to coefficient estimates of the specific explanatory variable over the well-being distribution while horizontal axes illustrate the quantiles of the dependent variable. In addition, the grey-shaded area corresponds to bootstrapped 95% confidence intervals.

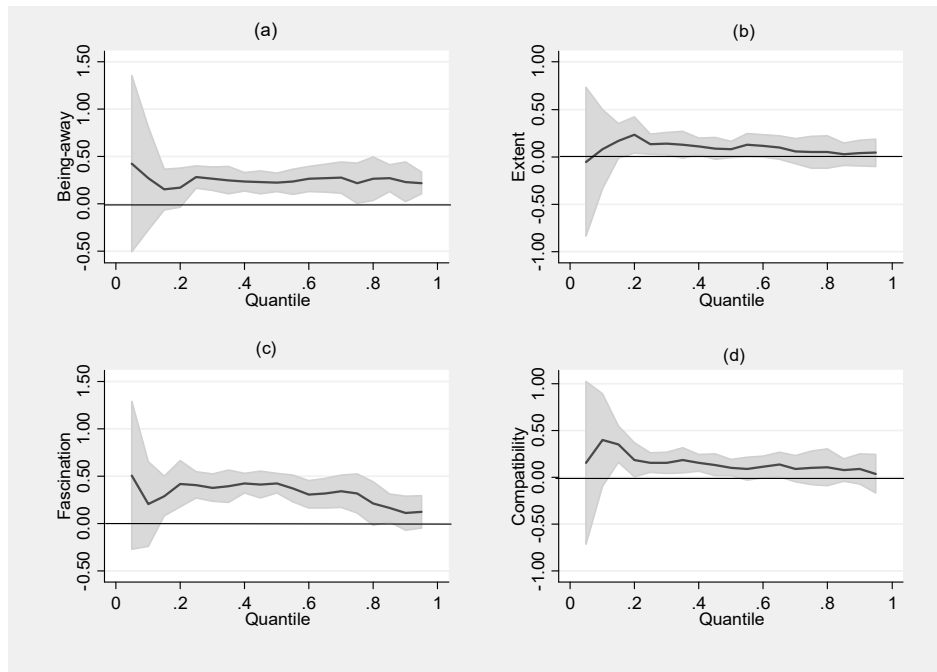


Fig. 3. Bootstrap 95% confidence interval (grey-shaded area) of quantile regression estimates for psychological well-being

Focusing on psychological well-being, we found that getting distance from ordinarily routine (being-away) significantly and positively predicts well-being throughout the entire distribution, except the first quantiles regarding the individuals least satisfied by pinewood fruition (Figure 3a). However, the significant segment of the curve, which is quite flat, suggests a pure location shift. Therefore, when the level of agreement towards the statement

“Being here enables me to run away from my daily routine” increases, the perceived psychological well-being increases by about the same amount in every quantile of the distribution.

Fascination, which is related to effortless attention, has a significant and positive influence, holding constant other covariates, on the central part of well-being distribution (between 0.25th and 0.75th quantiles).

The capability of the site to match individuals’ inclination and goals (*compatibility*) affects well-being only in the first quantiles (between 0.15th and 0.50th quantiles). The extension of the green area and the coherence of its elements (*extent*) does not affect psychological well-being in our sample.

Similar relations were found between ART components and physical well-being. However, some peculiarities can be identified. *Being-away* and *fascination* significantly influence the central part of the conditional distribution of the dependent variable with an increasing effect up to the 0.70th quantile when the magnitude of the coefficient decreases.

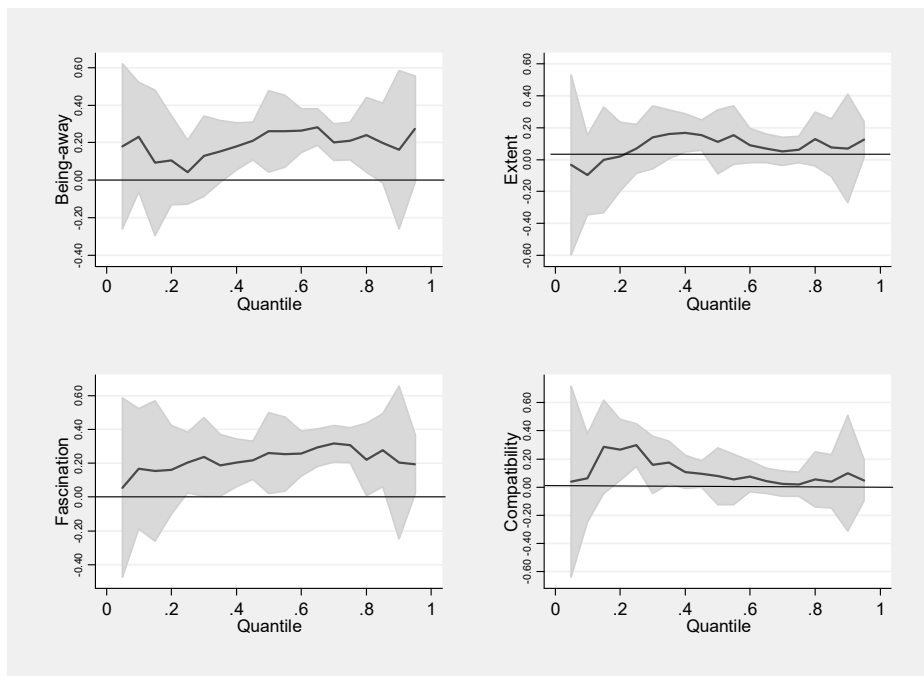


Fig. 4. Bootstrap 95% confidence interval (grey-shaded area) of quantile regression estimates for physical well-being

Concerning the comparison across the three different sites, visiting pinewoods with different forest structure has an effect on psychological and physical well-being. Specifically, visiting the pinewood in Castelfusano - characterized by a very complex forest structure - is significantly and negatively related to perceived well-being in the central and high part of the distribution (Figure 5), compared to the pinewood in Montalto Marina. On the other hand, no significant differences were found comparing the pinewood in Fregene and the pinewood in Montalto Marina, two sites sharing similar forest characteristics.

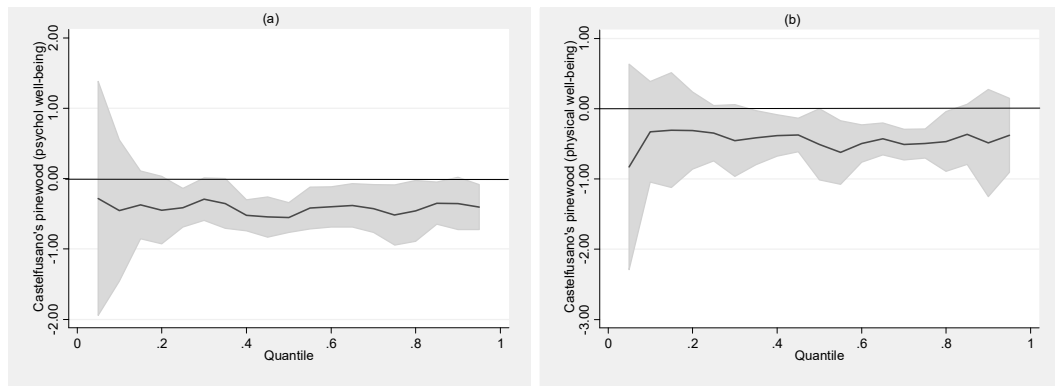


Fig. 5. Bootstrap 95% confidence interval of quantile regression estimates for the effect of site on: a) psychological and b) physical well-being

4. Discussion and conclusions

The major findings of this study support the evidence emerged from previous studies highlighting that individuals' receive mental and physical benefits from visiting urban and peri-urban green areas. By applying quantile regression models we tested the effects of explanatory variables on different quantiles of the psychological and physical well-being distribution. Indeed, if the effects are not uniform along the distribution of the dependent variable, standard regression techniques would return only a partial picture of the relationship between dependent variable and hypothesized covariates. Our results show that the effect of the selected covariates is different both throughout the distribution of the dependent variable and between the two self-reported measures of psychological and physical well-being. Intrinsic restoration properties of the green areas, of which fascination and being-away represent the manifest measure, proved to be important predictors of well-being, except for the least satisfied individuals who fail to capture the aesthetic beauty and attractive stimuli that allow the regeneration of the direct attention. This is probably due to the effect of other dimensions of subjective well-being such as social and economic characteristics which are not considered in our study. The same characteristics do not affect the most satisfied individuals who receive benefits from green areas regardless their perceived restorative properties. On the other hand, while the effect of fascination and being-away is positive but constant in magnitude along the central part of psychological well-being distribution, we found an increasing and positive (even if weakly) effect on physical well-being.

Lastly, visiting pinewoods with more complex stand structure is associated to a lower perceived well-being (both physical and psychological), compared to visiting simplified ones. This might be related to the fact that, in the presence of a vertical profile composed by multiple layers, individuals cannot reach any part of the green area and their view is limited therefore reducing the perception of a safe place.

Our preliminary and explorative results represent a good starting point for a deeper analysis required when planning social policies. On one hand, focusing on the extremes of distribution can contribute to plan effective interventions that fulfill not only the needs of the "average" individual. On the other hand, we think that the planning and management of a forest area for recreational purposes should carefully take into account its stand structure and dynamics (Barbati et al. 2013, Marchetti et al. 2014).

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