# UNIVERSITA' DEGLI STUDI DI PADOVA


**DIPARTIMENTO DI SCIENZE ECONOMICHE ED AZIENDALI "M.FANNO"**

**CORSO DI LAUREA MAGISTRALE / SPECIALISTICA IN ECONOMICS AND FINANCE**


**TESI DI LAUREA**

## A DISCRETE CHOICE EXPERIMENT ON TRANSPLANTED PATIENTS' PREFERENCES IN KIDNEY ALLOCATION


**RELATORE:**

**CH.MO PROF. ANTONIO NICOLÒ**

**LAUREANDA:**
**ELENA MARCHETTI**

**MATRICOLA N. 1130673**


**ANNO ACCADEMICO 2016 – 2017**

Il candidato dichiara che il presente lavoro è originale e non è già stato sottoposto, in tutto o in parte, per il conseguimento di un titolo accademico in altre Università italiane o straniere.
Il candidato dichiara altresì che tutti i materiali utilizzati durante la preparazione dell'elaborato sono stati indicati nel testo e nella sezione "Riferimenti bibliografici" e che le eventuali citazioni testuali sono individuabili attraverso l'esplicito richiamo alla pubblicazione originale.

Firma dello studente

# Syllabus

# Introduction

This paper is going to present the methodology, the literature and the application of Discrete Choice Experiments (DCE) in Health Economics.

In the first chapter we give a definition of DCEs, describing the theoretical principles on which these experiments are based, and how to undertake a DCE. We go through each methodological step to conduct a discrete choice experiment, studying in deep how to conceptualize the choice process, how to correctly define attributes and levels, and how to create the experimental design. Moreover we analyze the importance of conducting a pilot test for the experiment, and the importance of a careful selection of the sample and the coding methods. A central part in this chapter is the description and examination of the main econometric models used in DCEs, with their different strengths and weaknesses. The last sections of Chapter I aim to present the validity and the interpretation of the results obtained from the discrete choice experiments, highlighting the most problematic points in these phases.

Chapter II presents an overview of the literature about discrete choice experiments, with a particular focus on Health Economics. This analysis concerns both the DCE application areas, and the most used methodological characteristics of these studies, providing statistics and data about the majority of the discrete choice experiments conducted in this field. Finally, the chapter provides some particularly significant examples of DCEs in health economics, and some critiques and limits of this technique, that we have to be aware of before undertaking our quantitative analysis.

In the third chapter we are going to present a research project of the University of Padova, which aims to incorporate patients' preferences in a new algorithm, in order to efficiently allocate organs. In particular, we will present the aim, the method and the results of the paper "Eliciting Patients' Preferences in Kidney Transplantation: A Discrete Choice Experiment", written by Genie, Nicolò and Pasini (2017).

This study was undertaken analyzing preferences of patients who are waiting for a kidney transplantation and represents the start point of our empirical analysis.

In Chapter IV, indeed, we will make our contribution to this research project, considering data and preferences collected by a DCE conducted with patients already transplanted. Under the advice of surgeons and nephrologists of the Ospedale di Padova, we selected four attributes of the kidneys candidate to be transplanted: Graft Survival, Infectious Risk, Neoplastic Risk and Waiting Time requested to receive the organ.
We compute patients' willingness to wait (WTW) for a change in the levels of kidney transplant attributes, in order to study respondents' time and risk preferences for kidney transplantation in Italy, and search for heterogeneity of tastes.

To analyze our data, we used a mixed logit model and we found that there is a clear evidence of heterogeneity of preferences, which should not be ignored in the organ allocation process.
So far, the allocation algorithm has accounted for patients' (medical and personal) observable characteristics, such as age and time spent on dialysis, but it has never taken in consideration recipients' intrinsic and unobservable tastes, such as patience, risk aversion, etc.
We think that accounting for individual preferences in organ allocation can improve patients' satisfaction, and the efficiency of the algorithm matching kidney and recipient.
On the other hand, it is important to be very careful in the preferences estimation process, which is a very delicate and complex exercise, in which several biases could arise, and the interpretation of results is often not easy.

# I. Discrete Choice Experiments

## 1. Definition

The discrete choice experiments (DCE) method is a preference valuation technique based on Lancaster's economic theory of value[1] and random utility theory[2] [3]. DCEs were originally developed in marketing research in the early 1970s, but in recent years they have had a growing importance for researchers who want to estimate the value of non-marketable commodities, most of all in public health-care system and in transport researches. These experiments request the construction of a set of alternatives based on a limited number of attributes.

Lancaster's characteristics theory of demand assumes that goods, services, or type of health care provisions can be valued in terms of their constituent characteristics (*attributes*). Presenting two or more alternatives and asking respondents to choose between them, analysts obtain an indication of preferences over those alternatives.

The random utility theory assumes respondents to take their decision in a utility maximizing manner and make choices contingent, upon the levels of attributes in DCE scenarios.

Then, choice data obtained from respondents can be analyzed using micro-econometric in order to understand how the average individual's utility is affected by the changes in the levels of each attribute. Individual utility can be divided into two different components: the systematic part, that is a function of attributes and their levels, and a random component, that is the error term in the regression equation related to unmeasured preference variation.

We define: $U_{iq}(A) = v_{iq}(A) + \varepsilon_{iq}$

1 Lancaster, K. (1966).

[2] McFadden D. (1974).

[3] Hanemann, W. (1984).

where $U_{iq}(A)$ is the indirect utility function of individual $q$ for good $i$ with attributes $A$, $v_{iq}(A)$ is the measurable (systematic) component of utility estimated empirically and $\varepsilon_{iq}$ represents the unobservable factor.
The subject will choose $i$ over $j$ if:

$$(v_{iq}+\varepsilon_{iq})>(v_{jq}+\varepsilon_{jq})$$

or

$$(v_{iq}-v_{jq})>(\varepsilon_{jq}-\varepsilon_{iq}).$$

The probability for individual $q$ to choose alternative $i$ over $j$, with the set of attributes $A$ and the choice set $C$, is given by the probability that difference between the measurable components of $i$ and $q$ is higher than the error difference:

$$P(i_q|A,C)=Pi=[(v_{iq}-v_{jq})>(\varepsilon_{jq}-\varepsilon_{iq})].$$

Assuming that price, or some proxy for that, is included as an attribute in the choice set, willingness to pay (WTP) can be indirectly estimated for both changes in individual attributes, as well as changes in any combination of attributes. Assuming a linear utility function, then:

$$V= \chi_0+\Sigma\chi_nX_n+\delta P+\theta$$

with $\chi_0$, $\chi_n$, $\delta$ as parameters of the model to be estimated, where $\chi_0$ is the constant that reflects the individual's preferences for a commodity over another, when all the attributes remain the same; $X_n$ as the levels of the $n$ attributes of the commodity being valued; $\Sigma\chi_nX_n$ as the sum of all the effect coefficients; P the price level or some proxy for that; $\theta$ the unobservable error term. Following from this it is possible to estimate the respondent's willingness to pay (WTP) for a change in the provision of a service or the welfare impact of a change in policy:

$$WTP= (\Sigma\chi_nX_n)/\delta.$$

In order to have a deeper and more practical understanding of DCE technique, we are going to analyze how to conduct a discrete choice experiment seeing the method, the details and the critical points in the construction of these experiments.

## 2. Methodology: undertaking a DCE

Lancsar and Louviere[4] published in 2008 an "User's guide" to discrete choice experiments. The authors highlight three interrelated components of conducting a DCE:

A) the experimental design used to implement the choice survey and generate choice data;

B) the discrete choice analysis to estimate preferences from the choice data;

C) the use of the resulting model to derive welfare measures and conduct other polices analyses.

These components are then divided in the fourteen different steps:

Phase A

1) Conceptualizing the choice process
2) Attribute selection
3) Level selection
4) Experimental design
5) Questionnaire design
6) Piloting
7) Population/study perspective
8) Sample and sample size
9) Data collection

Phase B:

10) Coding of data
11) Econometrics analysis
12) Validity

Phase C:

13) Interpretation
14) Welfare and policy analysis

In this section we aim to define and analyze in detail the main phases in assessing the quality of a DCE. We will discuss and summarize some of the points above in order to better understand the entire process of conducting a discrete choice experiment.

[4] Lancsar, E. and Louviere, J. (2008)..

### 2.1 Conceptualizing the Choice Process

The first phase, necessary to generate choice data, requires consideration of choice contest, composition of choice set, framing of instructions and questions, and their incentive compatibility in order to encourage respondents to reveal true preferences. The researcher has to decide if the choice format is going to include choice between pairs of alternatives, multiple options, binary yes/no choices, or if the choice alternatives are going to be generic (ex: therapy A, therapy B) or labelled (ex: dialysis, kidney transplantation). It is important to point out that, in the case of choice among hypothetical pairs, respondents are forced to choose even when both the alternatives result unappealing and neither of these would be chosen in practice. The implicit assumption that respondents always choose to consume a good/service raises problems of how to interpret the resulting preferences. This issue can be avoided allowing respondents to opt out, choose neither option or choose a set status quo option. In this last case it is important to understand what opt out option, or status quo option, means to respondents, for example, the latter could be seen as a reference point for gains or for losses and it can be the same for all the respondents or can vary. Last but not least, it is important to investigate how much experience/knowledge respondents have with the good/service in analysis, and what background information and education to provide in order to make respondents properly familiar with the arguments and aware of all the implications involved.

### 2.2 Defining Attributes and Levels

In DCE studies both quantitative (ex: waiting time) and qualitative (ex: provider of care) attributes are often defined and used, but they may not include every attribute important for every respondent. For this reason, it is important to well identify the salient attributes to the majority of respondents in order minimize any possible inference about omitted attributes. Another distinction about attributes that has to be taken in consideration is whether they have to be *generic* or *alternative specific*, in the former case attributes have the same levels for all the alternatives, in the latter some attributes or levels (or both) differ across alternatives. In DCEs also unavailable alternatives, such as new horizon medications, can be included by stretching level ranges as long as alternatives are plausible and possible to apply.

Special attention has to be put on risk attributes (such as risk of morbidity, mortality, infections, rejection of an organ or other risks associated with different health states) because it has been shown in psychological literature that individuals have difficulty in interpreting

risk probabilities, viewing events as more likely if they are familiar; hazard as less risky for themselves than for other people[5].

The number of levels chosen for the analysis is also relevant: for examples two-level attributes only allow estimation of a linear effect, which can be a quite important limitation in the model because attributes often exhibit non-linear effects. By the way the correct number of attributes levels is context specific, a high number is able to provide more information and details, on the other hand it increases task complexity and response variability.

### 2.3 Creating Experimental Design

An experimental design is a sample from all possible combinations of attributes levels used to define choice alternatives and choice sets, it can be obtained from catalogues, created using software, or by hand. This phase is particularly important for the DCE data generation process. The design produces the estimation matrix and respondents provide the dependent variables (choices) and co-variates such as socio-demographics. We can distinguish between a *full factorial* design or a *fractional factorial* design. The former is composed by a complete census of all attribute level combinations (if there are X attributes and all have Y levels, the full factorial is $X^Y$), it allows the estimation of all the main effects and the interaction effects between attributes, but it is often considered too large to be used in practice. About this last consideration Lancsar and Louviere argue that they are more feasible than many researchers think. The authors suggest that full factorials can be blocked into different versions which can be randomly assigned to respondents. This would provide more design points without increasing the number of choice sets for each respondent, on the other hand this strategy can complicate the following econometric analysis.

The fractional factorial design is a sample selected from the full fractional, in a way that guarantees to estimate all the effects of interest in the analysis, such as the main effects and the most relevant interaction effects. It is usually recommended avoiding small fractional designs and, instead, implementing the largest possible design given constraints, such as research budgets and task complexity. Also, fractional factorials can be blocked into versions with a bit more complex process than that described above for the full factorial.

Two key points in creating an experimental design are identification and efficiency. Identification determines the effects that can be estimated independently, and efficiency refers to the precision with which the effects are estimated and how precise parameter estimates are, given a sample size. As we said above, many sources suggest to introduce opt out or status

[5] Loyd A. (2001).

quo options : they reduce the efficiency of the experimental design but they guarantee a better congruency with consumer theory and real preferences of individuals.

Huber and Zwerina[6] define other four design desirable criteria:

i) Orthogonality: attribute levels in choice appear equally often with each level of each other attribute.

ii) Level balance: levels of each attribute appear with the same frequency.

iii) Minimum overlap of levels for each attribute in each choice.

iv) Utility balance: options in each choice set have almost the same probability of being chosen.

These criteria have been criticized both by Street and Burges[7] and Viney et al.[8] arguing that these properties do not guarantee the optimality of the design. On the contrary, some of them, for instance utility balance, can even increase the variance of error component, that can consequently impact negatively on parameter estimates.

### 2.4 Pilot Test

This phase is needed to test DCE surveys in their different parts, in an attempt to predict an appropriate sample size and improve the experiment design. Pilot tests evaluate generation method, and respondents understanding of choice context, attributes and levels. Moreover, they are important to check task complexity, the length of the survey, timing, costs, feasibility, likely response rate, adverse events and statistical variability, in order to avoid wasting time and money on an inadequately design project.[9]

### 2.5 Sample and coding

As in any experiment, DCEs sampling requires consideration about population, opportunity costs, program founding, inclusion and exclusion criteria, and relevant perspective. The optimal sample size has to be chosen to allow a reliable estimation of models, respecting research constraints such as budget and time. It varies with the experimental design, since the number of observation should change with the number of choice sets, per respondent, and the number of respondents in the sample.

Coding is the first phase for discrete choice analysis and interpretation of results. It can be useful to briefly remind that, for qualitative attributes, it is better to use effects coding[10] or

[6] Huber, J. and Zwerina, K. (1996).
[7] Street D.J. and Burgess L. (2008).
[8] Viney, R., Savage, E. and Louviere, J. (2005).
[9] En.wikipedia.org. (2017). Pilot experiment.
[10] Bech, M. and Gyrd-Hansen, D. (2005).

dummy variables, while mean-centering numerical attributes are used when we want to specify non-linear effects for quantitative attributes, such as quadratic or cubic effects.

### 2.6 Econometric analysis models

The form of the estimated indirect utility function is linked with the type of choice modelled (binary or multiple choices), the experimental design, the interaction effects and the alternatives definitions (generic or labelled). Consequently, choice models depend on different assumptions about distribution, properties of errors and on variance-covariance matrices. For this reason, there are a great variety of different econometric models, which can be applied in DCEs studies. Below we will briefly describe the three models most used in recent years, which are considered the most suitable, even for health economics DCE analysis.

Random Effects Probit Model: a regression model where the dependent variable can take only two values, and the underlying assumption is that the individual specific effects are uncorrelated with the independent variables. The purpose of the regression is to estimate the probability that an observation with particular characteristics falls into a specific category.[11] A limitation of probit model is that it cannot utilize any distribution for the random coefficients, but only the Normal.

Multinomial Logit Model: this classification method has the advantage of being able to cater more than two response options, they can also allow respondents to "opt-out" from making a decision and they are sometimes associated with a better "goodness of fit". Multinomial logit model, also known as multiclass LR or conditional maximum entropy model, predicts the probabilities of the different possible outcomes of a categorical (or nominal[12]) dependent variable, given a set of independent variables. The main assumptions under this model are that data have to be case specific, the dependent variable cannot be perfectly predicted from the independent variables for any case, and collinearity is relatively low, otherwise it is difficult to differentiate between the impact of several variables. However multinomial logit model does not need the assumption of statistical independence between independent variables, but it relies on the independence of irrelevant alternatives[13], which is not always desirable. The

[11] En.wikipedia.org. (2017). *Random effects model*.

[12] *Categorical* or *Nominal* dependent variable means that it falls into any one of a set of categories which cannot be ordered in any meaningful way.

[13] *Independence of irrelative alternatives* assumption states that the odds of preferring one class over another do not depend on the presence or absence of other "irrelevant" alternatives.

growing use of this procedure reflects the increased use of DCEs incorporating more than two choices, or two choices plus an opt-out.

Mixed Logit Model: is a fully general statistical model for examining discrete choices which, in recent years, has had a sharp increase in its adoption in DCEs studies. This model overcomes the limitations of the standard logit models by allowing for random taste variation, unrestricted substitution patterns and correlation in observed factors over time.[14] With an appropriate specification of variables and distribution of random coefficients (mixed logit can utilize any distribution), this model is able to approximate, to any degree of accuracy, any random utility model[15]. Moreover, it can accommodate the panel nature of DCE data by allowing correlation within subjects over repeated choices. It allows for preference heterogeneity across individuals by allowing parameters to vary randomly across individuals. A limitation of mixed logit approach is that it requires the imposition of assumptions on the distribution of the random coefficients for the validity of findings about preference heterogeneity. Normal distribution is commonly applied in literature, but it has been argued that other distributions, such as bounded distribution[16], could be more appropriate, or that the distribution of parameters may not be of any standard form. Another possible shortcoming derives from the fact that mixed logit model has to be based on a set of well-grounded hypotheses, supported by theory concerning researchers' a priori expectations on population's behavior. In spite of that, Louviere and Eagle[17] argued that most of the current mixed logit studies still rely on statistical theory and not on behavioral theory.

### 2.7 Validity

Validity refers to the degree to which evidence and theory support the interpretations of test scores, entailed by proposed uses of tests[18]. There are different types of validity tests used in economics, here we focus on the most used validation process applied in DCEs: the internal validity test. Nevertheless, we will see other examples of validity test in the next chapter reviewing the literature of discrete choice experiments in health economics.

Tests for internal theoretical validity[19] involve an assessment of whether coefficients appear to move in line with a priori expectations and theoretical rules. In the studies it is generally reported that this was the case. A more indirect test of theoretical validity is to consider

[14] Train, K. (2009).

[15] McFadden, D. and Train, K. (2000).

[16] Train K, Sonnier G.

[17] Louviere J, Eagle T. (2006).

[18] American Educational Research Association, American Psychological Association, & National Council on Measurement in Education. (1999)

[19] Heukelom F. (2009).

whether results are consistent with intuition, for example in health economics we may expect that patients who have experienced an illness value treatment differently from those with no experience, even if economic theory has nothing to say about the relationship between value and experience.

It can be also tested whether results conform to the axioms of consumer theory: many researchers analyzed "rationality" of choices (often referred to as internal consistency) and excluded "irrational" individuals from analyses. In order to test for rationality, dominance tests and transitivity tests have been often used in DCEs studies. The former includes a choice set where one alternative is clearly superior, in order to check if respondents are able to identify and chose it. The latter would imply observing the following choice pattern: if Choice A is preferred to Choice B and Choice B is preferred to Choice C, then Choice A has to be preferred to Choice C.

Lancsar and Louviere[20] point out several problems in testing rationality in a reliable way. Indeed, apparent irrationality may be due to:

i) Shortcomings in design and implementation of DCEs;
ii) Respondent learning about their preferences or tasks;
iii) Irrationality tests not being conclusive;
iv) Use of fractional factorials, which cannot identify unique decision rules.

For these reasons we have to be careful deleting these respondents, because it may omit valid preferences leading to bias and lower econometrical efficiency. Lancsar and Louviere conclude that random utility theory allows for random errors and, therefore, also "irrational" responses should be included in the analysis.

There has been a debate[21] [22] [23]also about the relation between adherence to economic axioms and complexity of DCE design: literature from psychology affirms that reliance on simple decision-making strategies increases with complexity of tasks.

As we will notice also in next chapters, all these issues make the validation process a very delicate phase in constructing a discrete choice experiment.

### 2.8 Interpretation, Derivation of Welfare Measure and Other Policy Analysis

After estimating the preference model, we have to decide how to use it in policy analysis. One of the central issues in this process phase is how to set the relative importance of attributes. For instance, when choosing diagnostic tests, we have to define if waiting time is relatively

[20] Lancsar, E. and Louviere, J. (2006).
[21] De Palma , Myers G, papageorgious Y. (1994).
[22]Scott A. (2002).
[23] Leave, C., Payne, J., Bettman, J. and Johnson, E. (1994).

more important than test accuracy to the patient, or, in an organ transplantation, if risk of post-operation infections is valued more, by the patient, than risk of rejection. In order to decide that many studies measure relative impact of attributes by comparing size and significance of estimated attribute parameters. The main problem is that this kind of parameters are not easily comparable, because they often do not have a common scale of evaluation. There are various methods to compare relative attribute impact, here we will just cite the three most used ones, which are:

-Predicted probability analysis;

-Marginal Rate of Substitution;

-Welfare Measure to Value Health and Healthcare.[24]

To conclude this chapter we report below a table by Lancsar and Louvier[3], it is an useful guideline to summarize all the phases to consider in undertaking a Discrete Choice Experiment, with the relative significant issues for each part of this process.

[24] Lancsar E, Louviere J, Flynn T. (2007).

| | |
|---|---|
| **1. Conceptualizing the choice process** | Was a choice rather than ranking, rating task used?<br>What type of choice was used: binary response, pairs, multiple options?<br>Was a generic or labelled choice used?<br>Was an opt-out, neither or status quo option included?<br>If a forced choice was used, was a justification provided?<br>Was the task incentive compatible? |
| **2. Attribute selection** | How were they derived and validated?<br>Was the number of attributes appropriate?<br>Was the coverage appropriate?<br>What form was used: generic or alternative specific?<br>Was price included? If so, was an appropriate payment vehicle used?<br>Was risk included? If so, was it appropriately communicated? |
| **3. Level selection** | How were they derived and validated?<br>Was the number of levels per attribute appropriate?<br>Was an appropriate range used?<br>Were the levels evenly spaced? |
| **4. Experimental design** | What type of design was used? Full factorial? Fractional factorial? If fractional, which effects are identified: main effects; main effects + higher order interactions?<br>How were the profiles generated and allocated to choice sets?<br>What are the properties of the design?<br>What is the efficiency of the design?<br>Was identification checked (e.g. is the variance-co-variance matrix block diagonal)?<br>Was the design blocked into versions? If so, how were choice sets allocated to versions? Were the resulting properties of the versions checked?<br>Were respondents randomly allocated to versions?<br>How many choice sets were considered per respondent?<br>If some profiles were implausible – how was implausibility defined and how was it addressed? |
| **5. Questionnaire design** | Was an appropriate level of background and contextual information provided?<br>Were the task instructions appropriate?<br>Was the medium used to communicate attribute/level information (e.g. words, pictures, multi-media) appropriate? |
| **6. Piloting** | Was coverage of attributes and levels checked?<br>Was understanding and complexity checked?<br>Was the length and timing checked? |
| **7. Population/study perspective** | Appropriate for research question? |
| **8. Sample and sample size** | Were inclusion/exclusion criteria explicit?<br>Was sample size appropriate for model estimation? |
| **9. Data collection** | What recruitment method was used?<br>How were data collected (e.g. mail, personal interview, web survey)?<br>What was the response rate?<br>Were incentives used to enhance response rates? |
| **10. Coding of data** | Was coding explicitly discussed?<br>Was the coding appropriate for effects to be estimated? |
| **11. Econometric analysis** | Were the estimation methods appropriate given experimental design and type of choice response?<br>Was the functional form of the indirect utility functions appropriate given the experimental design?<br>Were alternative specific constants included?<br>Were sociodemographics and other co-variates included?<br>Was goodness of fit considered? |
| **12. Validity** | Was internal or external validity investigated?<br>Were answers for any respondents deleted and if so on what basis? |
| **13. Interpretation** | Was the interpretation appropriate given coding of data?<br>Were results in line with *a priori* expectations?<br>Were relative attribute effects compared using a common and comparable metric? |
| **14. Welfare and policy analysis** | Was willingness to pay estimated using welfare theoretic compensating variation?<br>Was probability analysis undertaken?<br>Were marginal rates of substitution calculated? |

# II. Literature about Discrete Choice Experiments in Health Economics

## 1. DCE application areas and Health Care Sector

Discrete Choice experiments were applied for the first time in marketing by Louviere and Woodworth in 1983[25], but they found quickly success also in applied economics, particularly thanks to studies about transports and environmental economics. Propper[26] was the first to apply a DCE to the health care sector, then there has been a quick increase in the use of DCEs in order to elicit preferences for healthcare products and programs, contributing to outcome measurement for the use in both cost-benefit and cost-utility analysis.

One of the main reasons of the success of these experiments in healthcare is that, in this sector, the economic issue of limited resources, and unlimited claims on resources, is particularly relevant. There are several decisions in health economics which require facing the problem of scarcity, combined with the urgency to make choices between competing claims on resources (during the evaluation of appropriate forms of healthcare financing, during the evaluation of individual pharmaceuticals or about some service delivery).

Another important reason of the increasing use of DCEs in health economics is that it well faces the problem of lack of revealed preferences data in this sector. This is plausibly due to the presence of public and private insurances, that means that patients/consumers rarely face market prices, and agency relationship between patients and doctors/physicians, which implies that consumptions do not depend only on patient preferences. Another cause may be the existence of interventions not available in the market, about which market data relating to these do not yet exist. The great advantage of DCEs here is that they allow to use *stated preferences*, i.e. what individual say they would do rather than what they are observed to do[27],

[25] Louviere, J. and Woodworth, G. (1983).

[26] Propper, C. (1990). .

[27] DCEs are not the only *stated preference* method commonly used in health sector to investigate preferences and to value health outcomes; we should also remind standard gamble, time trade-off, person trade-off and contingent valuation. [ Jonsson, M. and Alban, A. (1988).]

involving generation and analysis of choice data. DCEs are able to mimic existing markets and, also, to create hypothetical and inexistent markets. In this way they provide rich data sources for economic evaluation and decision making, and allow investigation of questions that would be analytically intractable otherwise.

Governments and other funders are increasingly interested in public and patience preferences in order to plan the levels of healthcare provision, value health outcomes, study the expected uptake of new polices/products, and improve clinical/policy decision making and adherence with clinical/public health programs. DCEs are often applied also to pharmaceuticals, health insurance and health technologies fields. They contribute in eliciting preferences and quantifying trade-offs for features, describing products and programs in clinical setting, and in other contexts such as preferred health insurance packages, health services configurations, time preferences, job choices, lifestyle behavior and priority setting frameworks.

## 2. Literature Review

In recent years some systematic literature reviews have been developed in order to analyze literature using DCEs in health economic studies. D. Clark, et al. ( 2014)[28] summarizes DCE literature covering three periods: 1990-2000, 2001-2008, 2009-2012.

We report below some statistics about the implementation of DCE studies in health economics in past years in order to analyze their trend and evolution. However, it is important to remember that this study has two limitations: it only includes English language studies, and it only uses PubMed (a limited database) to source literature.

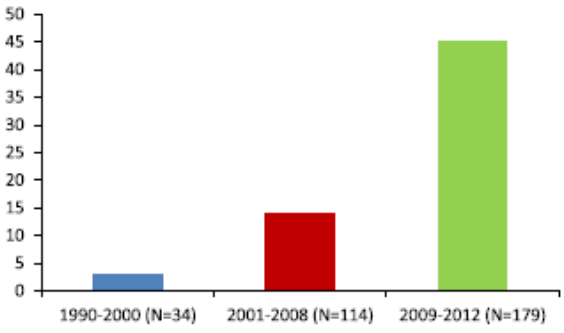



**Fig.1** Average number of DCEstudies/year [28]

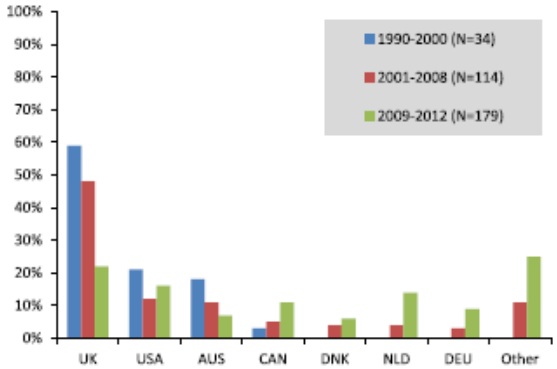



**Fig.2** Country of origin, AUS Australia, CAN Canada, DEU Germany, NDL Netherlands [28]

[28] Clark, M., Determann, D., Petrou, S., Moro, D. and de Bekker-Grob, E. (2014).

In Figure 1 we can see the average number of DCEs per year, published during each of the three periods. The number of publication rose from a mean of 3 application/year (1990-2000) to an average of 45 per year (2009-2012) with a peak of 74 in 2012.

Figure 2 summarizes the number of studies conducted from different countries. We notice that, in recent years, there has been an increasing trend in applying DCEs, before conducted mainly in UK, across both high-middle and low-income countries, which are indicated under the category "*other*".

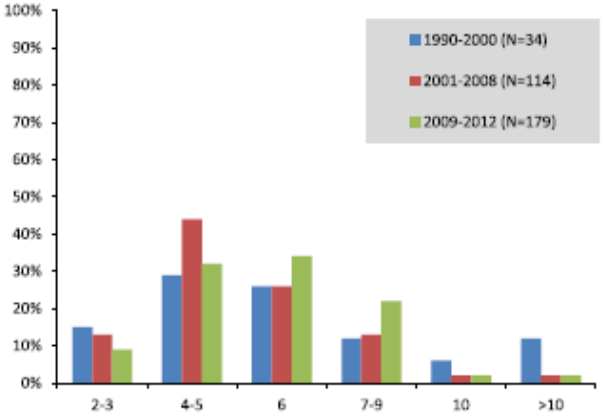



**Fig.3** Number of attributes [28]

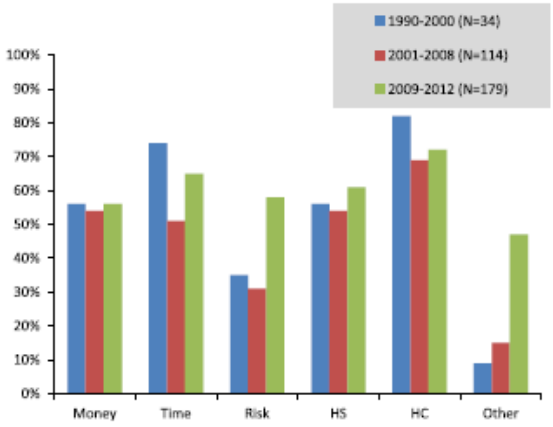



**Fig.4** Attributes domains, HC healthcare, HS health status [28]

Figure 3 and Figure 4 provide information respectively about the number of attributes used in DCE studies across the three time periods, and about different attributes domains divided in: *Money, Time, Risk, Health status (HS), Healthcare (HC),* and *Other*.

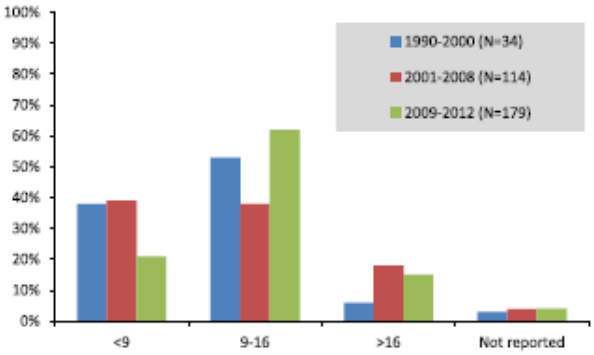



**Fig.5** Number of choice tasks [28]

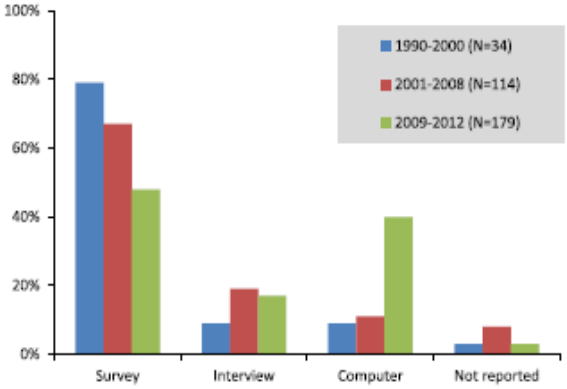



**Fig.6** Surveys administrations [28]

Figure 5 indicates the percentage of studies divided on the basis of the number of choice tasks posed by DCEs. We can notice that the majority of the analyses use a number of choice tasks between 9 and 16.

Figure 6 provides information about the different methods of survey administration chosen in the analyzed studies. We can notice the presence of a clear trend away from self-completed pen/paper questionnaires and, on the other hand, a sharp increase in the use of computers in administering DCEs, involving, always more, internet surveys. This is probably due to time saving in analyzing data gathered using computers, to the improvements in pc technology, and to the increased use of computers and internet by the world population, that see in Web an easy way to reach people, collect information and administrate surveys.

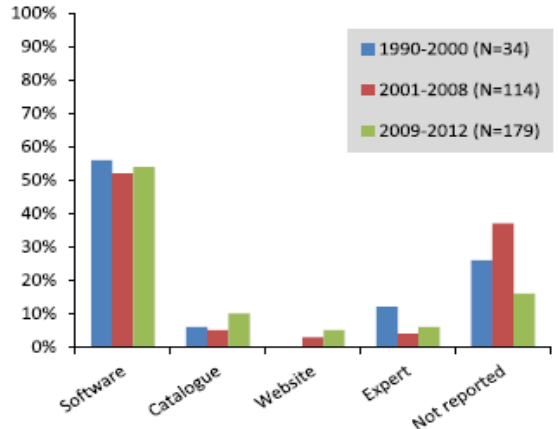



**Fig.7** Design source [28]

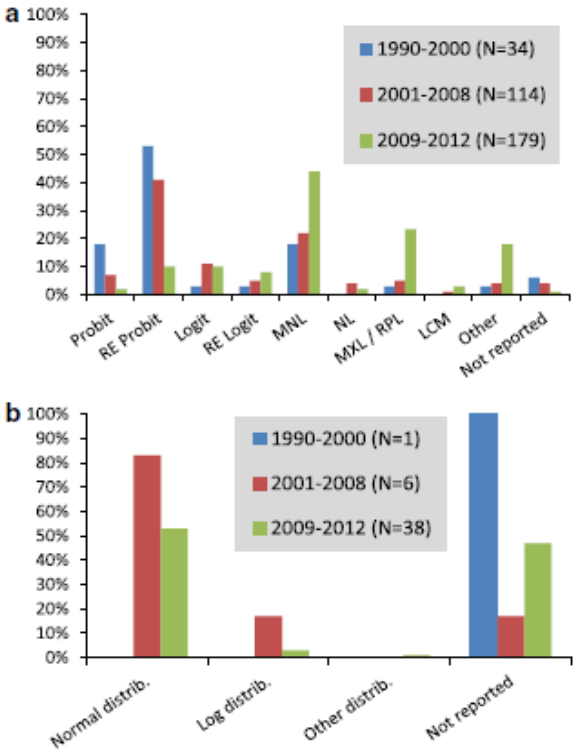



**Fig.8 a** Estimation procedures. **b** Distributional assumptions. *Distrib.* Distributions, *LCM* latent class model, *MNL* multinomial logit, *MXL/RPL* mixed logit/random parameters logit, *NL* nested logit, *RE* random effects [28]

Figure 7 summarizes the use of design catalogues, Websites, and Expert Advice to design DCE questionnaires, and shows that there has not been any particular big change in the use of these over the 20 years in analysis.

Figure 8 describes the econometric estimation procedures used and the distributional assumptions adopted. In this analysis it is important to point out that the econometric methods being increasingly used are those able to allow respondents to opt-out from registering a preference, in order to ensure that the choices, that respondents face, are realistic. Some important examples of the utility and the advantages of this technique can be found in a study about colorectal cancer[29] screening, and in a study evaluating two different smoking cessation mechanisms[30]. In the figure we can see that, as we anticipated in the previous chapter, the most used estimation methods in absolute terms over the three periods are: random effects probit (RE probit), Multinomial Logit (MNL), and mixed logit/ random parameters logit procedures (MXL/RPL).

[29] Hol L, et al. (2010)
[30] Marti J. (2012)

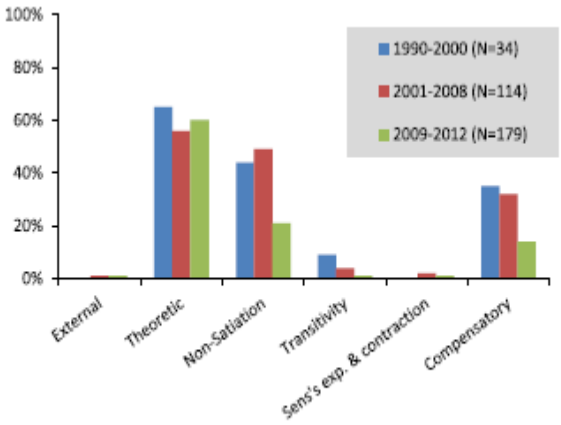



**Fig.9** Validity checks. *Exp.* expansion [28]

Figure 9 depicts different validity tests included in the analyzed studies. Given that many applications have taken place in countries with a publicly provided health care system, and therefore with a lack of secondary data sets to compare real and stated behavior, most analyses use tests for internal theoretical validity (*Theoretic*) which, as we saw in the previous chapter, are usually limited to checking if signs of estimated parameters are consistent with a priori expectations.

Texts of external validity (*External*) are particularly noteworthy, because stated preferences from DCEs can then be compared with revealed preferences. Unfortunately, as we can notice from the figure, there is often little scope to conduct this kind of test, because they are hard to apply, particularly when DCEs are conducted in the context of state funded health-care provision.

Another kind of tests quite used in these studies is that for non-satiation. This axiom of choice theory says that if, for any amount of a good or service, more is preferred to less, then more will be preferred to less also at all larger amounts of that good or service. These tests show a decreasing trend across years, probably because, recently, they started to be considered weak test of validity and they tend to be passed.

A small percentage of analyses contained transitivity tests (*Transitivity*).

Very few studies use a test relating to Sen's expansion and contraction properties (*Sen's exp. and contraction*): the application of this test implies that if Choice Set 1 is narrowed/expanded to form Choice Set 2, and the alternatives chosen in Choice Set 1 are also in Choice Set 2, then no unchosen alternative should be chosen and no chosen alternative should be unchosen.

Use of a test for internal compensatory decision making was much more frequent. One of the underlying assumptions of DCEs is that individual adopt compensatory decision making, i.e. they consider all the attributes included in the experiment and, based on the levels of all attributes, make a choice. These tests investigate whether individuals always choose according to the best levels of a given attribute.

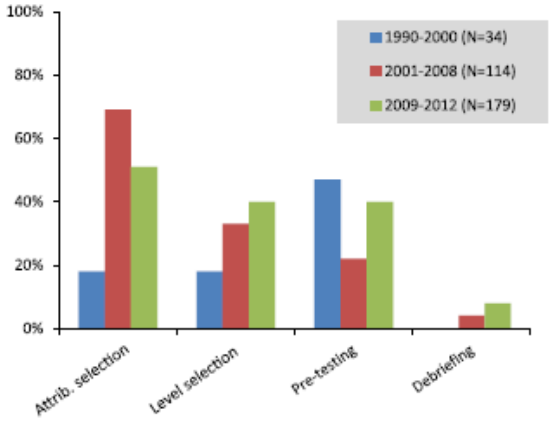



**Fig.10** Use of qualitative methods. *Attrib.* attribute [28]

However quantitative analyses are limited in identifying decisions strategies employed by respondents and qualitative work will prove useful in this area. Figure 10 represents the use of qualitative methods to enhance DCE processes. The use of qualitative methods to inform attribute selection (*Attrib. selection*) fluctuates between 2009 and 2012, showing a decline in the last period. A drop in the implementation of these techniques is potentially worrying because, if the selection of attributes is not properly grounded in qualitative research, there may be problems of triggering omitted variable bias (i.e. appropriate attributes which result omitted) and also some inappropriate attributes that are instead specified. On the other hand, a declining trend in the use of qualitative methods, to inform attribute selection, would be of little concern if it is triggered by the wider use of DCEs, in contexts in which the decision framework is already known (for example, if DCEs are conducted alongside clinical trials).

In contrast, the applications of other qualitative methods show different trends: the method used to inform attribute level selection (*Level selection*) increased over years; the use of a pre-testing questionnaire (*Pretesting*) fluctuated over time with an opposite trend with respect to that of attribute selection; the use of debriefing choices (*Debriefing*), to help strengthen understanding, started from a 0% in 1990–2000 analyses to increase until a 8 % 2009–2012.

Table 1: definition, and details of total number of analyses in each category [28]

| Category | Definition of category | Number of analyses, and number of papers the analyses are contained in | Other explanatory information |
|---|---|---|---|
| A | Patient or consumer experience factors | 25 (24) | Within this category, a paper by Damman et al. [ ] contains two analyses, one relating to knees, and another relating to cataracts; an analysis by Goodall et al. [ ] contains two analyses, one relating to patient preferences and another relating to carer preferences. There are also two papers cited for one analysis by Naik-Panvelkar et al. [ ] |
| B | Valuing health outcomes | 13 (13) | Not applicable |
| C | Investigating trade-offs between health outcomes and patient or consumer experience factors | 81 (81) | Within this category there are two papers by Morton et al [ ] which have been reviewed as one analysis. However, a paper by Regier et al. [ ] contained two analyses (one relating to fungal treatment, and the other relating to bacterial issues) |
| D | Estimating utility weights within the quality-adjusted life-year framework | 4 (4) | Not applicable |
| E | Job choices | 11 (8) | Within this category, a paper by Rockers et al. [ ] contains four analyses, one relating to medical student preferences, another relating to nursing student preferences, another relating to pharmacy student preferences, and another relating to science student preferences |
| F | Developing priority setting mechanism | 24 (23) | Within this category, the paper by Promberger et al. [184] contains two separate analyses for evaluation |
| G | Health professionals preferences for treatment and screening options | 24 (23) | Within this category, the paper by Regier et al. [ ] contains two separate analyses for evaluation. One of these relates to fungal infection and the other relates to bacterial infection |
| H | Other | 21 (21) | Not applicable |

Figure 11 shows the percentage of studies per areas of application, as defined in Table 1 (categories A, B, C, D, E, F, G, H). Although DCEs have originally been introduced into health economics primarily in order to value patient experience, there is clear evidence that the application of DCEs has broadened considerably by 2000–2008, and even more in 2009-2012[28]. The main noteworthy categories are category A and category C: the former involves valuing experience factors and it is specific to patient respondents. On the other hand, the latter deals with trade-off between health outcomes and experience factors and includes, also, estimations of trade-off for non-patient groups.

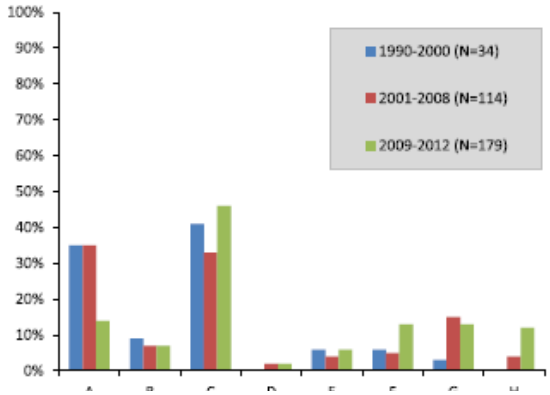



**Fig.11** Areas of application. For the definition of categories A, B, C, D, E, F, G, H refer to Table 1[28]

Finally, in Figure 12, we can observe information on trends relating to main outputs used in DCEs analyses, which are here divided in 'willingness to pay unit' outcome measures (*WTP*), 'per unit of time' outcome measures (*Time*), 'per risk unit' primary outcome (*Risk*), monetary welfare measures (*Money*), utility scores (*Utility*), odds ratios (*Odds*), probability scores (*Prob.*), and in the residual category *Other*. This last one reports data only for the time interval 2009-2012 and categorizes 49% of the analyses.

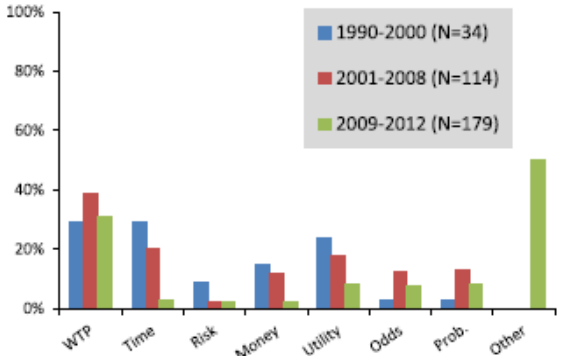



**Fig.12** Outcome measures, *Prob* probability, *WTP* willingness to pay [28]

The 2001–2008 analysis states that willingness to pay is still a commonly used output from DCEs over that period, but the most recent review shows evidence that the proportion of DCE studies using either "per WTP unit" or "monetary welfare measure" as their primary outcome is decreasing. This could be due to some concerns in relation to the use of DCEs to elicit WTP. Moreover, the hypothetical nature of DCEs can interfere with correct estimates of WTP because respondents are not bound by the choices they make[31]. Another problem can arise

[31] Regier, D., Diorio, et al. (2012).

when we estimate the marginal willingness to pay: we commonly assume that marginal utility of money is constant and the cost function is continuous and linear, but there are evidences that it is not always true[32].

In the next section we are going to analyze some relevant examples of discrete choice experiments in health economics in order to see how all the phases seen so far are practically implemented, and how DCEs are applied to different topics and in different areas.

## 3. Some examples of DCEs in Health Economics

We have seen that the use of DCEs in health economics has found a broad range of application in last year. In this part we decided to analyze two examples which can give a good insight into DCE utility and research value. The former paper well describes each phase of the experiment and shows a complex and detailed experimental design, useful for a better understanding about how DCEs are practically conducted in their parts. The latter gives a good insight about the implementation of mixed logit model in discrete choice experiments, and lays the foundations of the econometric theory we will use for the quantitative analysis in the next chapters.

### 3.1 *"Gaining pounds by losing pounds: preferences for lifestyle intervention to reduce obesity"*

This study[33] conducts a discrete choice experiment to investigate the population's preferences for alternative lifestyle interventions in order to reduce and prevent obesity. Data have been collected through a web-based questionnaire, with 504 UK adults responding. It is known that obesity is a global issue which is exponentially increasingly in recent years[34], if it continues at the current trend, more than half of the population in England will be obese in thirty years[35]. Being overweight raises the risk of morbidity for several illnesses such as type 2 diabetes, high blood pressure, heart attack, heart diseases and some types of cancer (such as colon cancer). A body mass index (BMI) between 30 and 35 can reduce life expectancy by an average of three years and when it is over 40 this can reduce life expectancy by eight/ten years. Conversely, it has been also proved that losing weight among overweight people reduces these risks.

[32] Johnson, F., Ozdemir, S. and Phillips, K. (2010).
[33] Ryan, et al. (2014).
[34] World Health Organization. (2017).
[35] Nhs.uk. (2017).

Obesity has been the cause for about 30.000 deaths per year in the UK, 9.000 of those before retirement age. We see that a very high number of overweight people register in weight-loss programs, but also that a huge number of those drop out before the program end. This study aims to investigate the factors that influence compliance with these programs, and with the propensity to take up and maintain healthy lifestyles. The DCE asks respondents to choose between different lifestyle intervention programs to reduce their weight in order to identify the efficiency of alternative obesity prevention programs.

Seven attributes have been selected for the experiment: content of the program, weight change after two years, short-term goal, reduced risk of developing type 2 diabetes, reduced risk of high blood pressure, time per day, and cost per week. The levels settled for each attribute are reported in the table below (Table 2).

Table 2: Attributes and levels within the discrete choice experiment [33]

| Attributes | Levels | Regression label | Regression coding |
|---|---|---|---|
| Categorical variables – effects coded | | | |
| Content of the programme | Healthy eating | *Content*1 | $\beta_1$ |
| | Healthy eating with support for management | *Content*2 | $\beta_2$ |
| | Physical activity | *Content*3 | $\beta_3$ |
| | Physical activity with support for management | *Content*4 | $\beta_4$ |
| | Healthy eating and physical activity | *Content*5 | $\beta_5$ |
| | Healthy eating and physical activity with support for management | *Content*6 | $\beta_6$ |
| Weight change after two years | No change | *Weight*0 | $\beta_7$ |
| | Lose half stone | *Weight*½ | $\beta_8$ |
| | Lose one stone | *Weight*1 | $\beta_9$ |
| | Lose one and half stone | *Weight*1½ | $\beta_{10}$ |
| Short-term goal | Look better | *Look better* | $\beta_{11}$ |
| | Feel better | *Feel better* | $\beta_{12}$ |
| | Look better and feel better | *Look better and Feel better* | $\beta_{13}$ |
| Reduced risk of developing type 2 diabetes[a] | No reduction | *DB_0* | $\beta_{14}$ |
| | Reduction by up to 20% → Small reduction | *DB_S* | $\beta_{15}$ |
| | Reduction by 20–40% → Moderate reduction | *DB_M* | $\beta_{16}$ |
| | Reduction by 40–60% → Large reduction | *DB_L* | $\beta_{17}$ |
| Reduced risk of high blood pressure[b] | No reduction | *HP_0* | $\beta_{18}$ |
| | Reduction by up to 25% → Small reduction | *HP_S* | $\beta_{19}$ |
| | Reduction by 25–50% → Moderate reduction | *HP_M* | $\beta_{20}$ |
| | Reduction by 50–75% → Large reduction | *HP_L* | $\beta_{21}$ |
| Continuous variables | | | |
| Time per day[c] | 30, 60, 90, 120 min | *Time per day* | $\beta_{22}$, $\beta_{23}$ |
| Costs per week | £1, £5, £10, £20 | *Costs per week* | $\beta_{24}$ |

[a,b]Levels for reduced risk of developing type 2 diabetes and high blood pressure were changed after pilots.
[c]A squared term, $\beta_{23}$, was included to allow for non-linearity in preferences.

The DCE questionnaire is generated using SAS software, which minimizes uncertainty around parameter estimates and generated an experimental design composed by 72 choice sets, to which a "Current lifestyle option" is added in order to make respondents choices more realistic. The study gathers information also about personal and socio-economic characteristics of respondents: age, height, weight, general health status, whether they smoke. Two Sen's expansion property tests are added in order to check whether respondents are engaged in the experiment. Authors include standard rationality tests and compare results with and without including "irrational" responses. Two pilots have been conducted by email, the first one had three version of the questionnaire, differing for the number of choices included

(40, 22, and 12 choices). Response rate for the three versions was low, therefore a new design with 24 choices divided in three blocks was developed, but also this second pilot registered a too poor response rate. Finally, a market research company used a web-based online survey to collect the final data set giving a financial incentive of £2 for completion.

Figure 13 shows an example of choice set.

Figure 13: Choice Set Example [33]

| Lifestyle | Lifestyle A | Lifestyle B | |
|---|---|---|---|
| The programme | Healthy eating and physical activity | Physical activity | |
| Weight change in 2 years | Lose half a stone | Lose a stone | |
| Short term goals | Feeling better | Looking better | |
| Reduction in risk of type 2 diabetes | Moderate reducing in risk | No reduction | |
| Reduction in risk of high blood pressure | No reduction | Small reducing in risk | |
| Time per day | 90 min/day | 30 min/day | |
| Costs per week | £5/week | £20/week | |
| Which option would you choose? | Choose Lifestyle A | Choose Lifestyle B | Current Lifestyle |
| *(tick one box only)* | ☐ | ☐ | ☐ |

Authors use a multinomial probit model to implement the econometric analysis estimating the equation reported below. They allow for a general covariance structure in error terms to address violations of independence of irrelevant alternatives.

$$V_{ij} = \beta_{0j} + \beta_1 Content1_{ij} + \beta_2 Content2_{ij} + \beta_3 Content3_{ij} + \beta_4 Content4_{ij} + \beta_5 Content5_{ij} + \beta_6 Content6_{ij} + \beta_7 Weight0_{ij} + \beta_8 Weight\ {}^{1}/_{2}{}_{ij} + \beta_9 Weight1_{ij} + \beta_{10} Weight1\ {}^{1}/_{2}{}_{ij} + \beta_{11} Look\ better_{jt} + \beta_{12} Feel\ better_{ij} + \beta_{13} Look\ better\ and\ feel\ better_{jt} + \beta_{14} DB\ 0_{ij} + \beta_{15} DB\ S_{ij} + \beta_{16} DB\ M_{ij} + \beta_{17} DB\ L_{ij} + \beta_{18} HP\ 0_{ij} + \beta_{19} HP\ S_{ij} + \beta_{20} HP\ M_{ij} + \beta_{21} HP\ L_{ij} + \beta_{22} Time\ per\ day_{ij} + \beta_{23} Time\ per\ day^{2}{}_{ij} + \beta_{24} Cost\ per\ week_{ij} i + \varepsilon_{ij}.$$

Where $V$ is the utility from the proposed lifestyle intervention program, and the different combinations of the attribute levels are those defined in Table 2.

Subscript $i$ denotes the individual respondent and $j$ the alternatives within a choice set. $\beta_{0j}$ is the alternative specific constant (ASC). $\varepsilon_{ij}$ is the error term, assumed to be normally distributed.

Table 3 and Table 4 show, respectively, the characteristics of respondents, and the probit regression results of preferences for lifestyle intervention. We notice that the positive and significant constant implies a general preference for current lifestyle. Moreover, we can observe that, despite evidences that diets are more effective in order to reduce weight,

respondents prefer to change their lifestyle, introducing or increasing physical activity, rather than a dietary intervention. Sensitivity to financial costs results significant, conversely, a behavior change support is shown to have poor value to respondents. This suggests that financial incentives may be used to promote healthy lifestyle interventions: men would require a higher compensation, and those of normal weight, who will gain weight over time without a proper change in their lifestyles, require the highest incentive.

Table 3: Characteristics of

| | Female | | Male | |
|---|---|---|---|---|
| | *n* | Mean | *n* | Mean |
| Age | 244 | 38.6 | 260 | 42.0 |
| 18–30 | 79 | | 69 | |
| 31–45 | 89 | | 75 | |
| 46–64 | 76 | | 116 | |
| Height (cm) | 244 | 164.7 | 260 | 178.3 |
| Weight (kg) | 244 | 72.5 | 260 | 84.6 |
| Body mass index (kg/m$^2$) | 244 | | 260 | |
| Underweight (<18.5) | 11 | 26.7 | 5 | 26.58 |
| Normal (⩽18.5 and <25) | 107 | | 103 | |
| Overweight (⩽25 and <30) | 71 | | 99 | |
| Obese (⩾30) | 55 | | 53 | |
| General health status | 244 | | 260 | |
| Very good (1) | 38 | 2.3 | 35 | 2.38 |
| Good (2) | 112 | | 122 | |
| Fair (3) | 81 | | 81 | |
| Bad (4) | 13 | | 19 | |
| Very bad (5) | 0 | | 3 | |
| Smoking | 244 | | 260 | |
| Currently smoking | 55 | | 57 | |
| Ex-smoker | 50 | | 77 | |
| Never smoked | 139 | | 126 | |
| Current lifestyle intervention | 244 | | 260 | |
| Healthy eating | 10 | | 16 | |
| Healthy eating with support | 9 | | 5 | |
| Physical activity | 16 | | 18 | |
| Physical activity with support | 2 | | 3 | |
| Health eating and physical activity | 17 | | 11 | |
| Health eating and physical activity with support | 6 | | 3 | |
| Doing nothing | 184 | | 204 | |
| Time spent per day (minutes) | 60 | 78.4 | 56 | 56.3 |
| Costs paid per week (£) | 60 | 9.6 | 56 | 9.13 |
| Those who chose current lifestyle only[a] | 49 | | 82 | |
| Not overweight | 10 | | 31 | |
| Satisfied with the current weight | 25 | | 55 | |
| Cannot afford to pay for the programme | 13 | | 22 | |
| Have alternative ways to maintain weight | 18 | | 24 | |

[a]Respondents could choose multiple responses.

Table 4: Probit Regression results of preferences for lifestyle interventions[33]

| | β | SE | Willingness to pay |
|---|---|---|---|
| Constant (=1 if *Current lifestyle*) | 0.7233*** | 0.2691 | 14.40 (7.04, 21.76) |
| Programme | | | |
| Healthy eating | –0.1311** | 0.0580 | –2.61 (–4.72, – 0.50) |
| Healthy eating with support for management | 0.0089 | 0.0449 | |
| Physical activity | –0.0060 | 0.0460 | |
| Physical activity with support for management | –0.0506 | 0.0518 | |
| Healthy eating and physical activity | 0.0810* | 0.0422 | 1.61 (–0.34, + 3.57) |
| Healthy eating and physical activity with support | 0.0978** | 0.0486 | 1.95 (+0.24, +3.65) |
| Weight change after two years | | | |
| No change | –0.0245 | 0.0381 | |
| Lose half a stone | 0.0287 | 0.0259 | |
| Lose one stone | –0.0515 | 0.0541 | |
| Lose one and half stone | 0.0472 | 0.0342 | |
| Short-term goal | | | |
| Look better | –0.0177 | 0.0249 | |
| Feel better | 0.0045 | 0.0189 | |
| Look better and feel better | 0.0133 | 0.0219 | |
| Risk reduction in diabetes | | | |
| No reduction | –0.1411*** | 0.0336 | –2.81 (–4.31, –1.31) |
| Small reduction | 0.0100 | 0.0315 | |
| Moderate reduction | 0.0420 | 0.0342 | |
| Large reduction | 0.0892** | 0.0351 | 1.77(+0.30, 3.25) |
| Risk reduction in high blood pressure | | | |
| No reduction | –0.1764*** | 0.0312 | –3.51 (–5.21, –1.81) |
| Small reduction | 0.0275 | 0.0270 | |
| Moderate reduction | 0.0038 | 0.0241 | |
| Large reduction | 0.1451*** | 0.0425 | 2.89 (+0.92, +4.86) |
| Time per day | 0.0207** | 0.0081 | 0.26 (+0.14, +0.38)[a] |
| Time per day$^2$ | –0.0001*** | 0.0001 | –0.06 (–0.10, –0.02)[a] |
| Cost per week | –0.0502*** | 0.0133 | |
| Log likelihood | –3668.4877 | | |
| Pseudo $R^2$ | 0.0084 | | |
| N of observations | 12,096 | | |
| N of individuals | 504 | | |

Huber cluster heteroskasdasticity errors estimated around choices from the same respondents.
[a]Calculated at 30 min.
*p < 0.10, **p < 0.05, ***p <0.01.

### 3.2 *"Preference heterogeneity and choice of cardiac rehabilitation program: Results from a discrete choice experiment"*

This paper[36] studies Danish patients' preferences for Cardiac Rehabilitation (CR) activities, using a discrete choice experiment. It is based on the assumption that factors influencing patients' utility include characteristics of rehabilitation programs, as well as personal features. The DCE considers five possible attributes/activities (physical exercise, personal meetings, group counseling meetings, diet guidance, smoking cessation course) with two levels each (Yes/No). They are better described in Table 5.

The experimental design was composed by 32 alternative programs, from those six alternatives were removed in order to ensure realism between the choice scenarios and actual CR programs, offered by hospitals in Copenhagen Country, and prevent the occurrence of

[36] Kjær, T. and Gyrd-Hansen, D. (2008).

dominant and dominated alternatives in the choice sets. Pilot tests have been implemented through a series of focus group interviews with cardiac patients from hospitals. Finally, 742 cardiac patients were asked to choose the preferred rehabilitation program for each of the eight choice sets. From those 511 of respondents answered at least one of the choice questions, with a satisfactory final response rate of 69%.

The econometric analysis has been realized using both a standard logit and a mixed logit model (reported as RPL: random parameter logit). This last model was chosen in order to test for taste heterogeneity in the cardiac activities and, as we have seen in the previous chapter, it requires some assumptions:

• the distribution of randomness in the coefficients was assumed a standard Normal with zero mean and variance equal to 1;

• all five attribute parameters are assumed to be random and normally distributed.

Moreover, the authors control for some heterogeneity in the mean introducing two interaction effects, which account for older people (coded = 1 for the oldest 25% of the sample,>75 years old; zero otherwise), and for smokers (coded = 1 for smokers, zero otherwise).

The results for both the estimation models are reported in Table 6.

The loglikelihood index ($R^2$) for the RPL model is considerably higher than in standard logit model, moreover the assumption of preference homogeneity is rejected, indeed the explanatory power of the mixed logit is significantly greater than with the logit model. We observe also that all five estimated attributes have standard deviations significant and relatively large, which confirms a high level of heterogeneity among respondents, even when age and smoking status are taken into account. For all these reasons we can conclude that, if the assumptions about parameters and distributions in the RPL model are not misleading, this model is far more suitable and reliable for this analysis.

The younger group of patients, on average, values the offer of personal meetings highest, followed by physical exercise and diet guidance.

On the other hand, patients aged 76 or older tend to value rehabilitation activities less attractive, we can see that, in the mixed logit model, all five interactions for elderly patients are negative and significant at a 5% level. We observe also that smokers value physical exercise and diet guidance less than non-smoking patients.

Table 5: Attributes, attribute levels and coding [36]

| Attributes | Further description | Levels | Coding |
|---|---|---|---|
| Physical exercises | Performed by physiotherapists | Yes | 1 |
| | | No | 0 |
| Personal meetings | With cardiac nurse. The description emphasized the control of risk factors | Yes | 1 |
| | | No | 0 |
| Group counseling meetings | Managed by cardiac nurses. The description emphasized psychosomatic issues | Yes | 1 |
| | | No | 0 |
| Diet guidance | Performed by dietician | Yes | 1 |
| | | No | 0 |
| Smoking cessation course | Performed by nurse | Yes | 1 |
| | | No | 0 |

Table 6: The regressions results [36]

| | | Model 1a logit | | Model 1b RPL | |
|---|---|---|---|---|---|
| | | Coefficient | (Standard error) | Coefficient | (Standard error) |
| Group meetings | Mean | 0.0217 | (0.0707) | 0.825** | (0.358) |
| | Standard deviation | | | 2.88*** | (0.521) |
| Physical exercises | Mean | 0.789*** | (0.0696) | 3.27*** | (0.548) |
| | Standard deviation | | | 3.42*** | (0.629) |
| Diet guidance | Mean | 0.646*** | (0.0734) | 2.65*** | (0.448) |
| | Standard deviation | | | 2.98*** | (0.587) |
| Personal meetings | Mean | 0.838*** | (0.0682) | 4.12*** | (0.717) |
| | Standard deviation | | | 3.57*** | (0.661) |
| Smoking cessation | Mean | −0.127* | (0.0657) | −0.510 | (0.369) |
| | Standard deviation | | | 4.56*** | (0.791) |
| Elderly | | | | | |
| ×Group meetings | | −0.229** | (0.110) | −1.25** | (0.497) |
| ×Physical exercises | | −0.476*** | (0.125) | −2.30*** | (0.731) |
| ×Diet guidance | | −0.201 | (0.145) | −1.14** | (0.570) |
| ×Personal meetings | | −0.409*** | (0.121) | −1.77*** | (0.608) |
| ×Smoking cessation | | −0.800*** | (0.119) | −3.89*** | (0.903) |
| Smokers | | | | | |
| ×Group meetings | | 0.00138 | (0.0837) | −0.127 | (0.440) |
| ×Physical exercises | | −0.359*** | (0.0973) | −1.34** | (0.527) |
| ×Diet guidance | | −0.250** | (0.102) | −1.092** | (0.487) |
| ×Personal meetings | | −0.124 | (0.0980) | −0.688 | (0.571) |
| ×Smoking cessation | | 0.534*** | (0.0892) | 2.38*** | (0.669) |
| Constant | | −0.191** | (0.0958) | 0.349 | (0.264) |
| LL (0) | | −2528.51 | | −2528.51 | |
| LL (model) | | −2165.19 | | −1826.18 | |
| $N$ ($n$) | | 3660(511) | | 3660(511) | |
| Adjusted pseudo $R^2$ | | 0.1382 | | 0.2717 | |
| LL-ratio test | | | | 678.02 | |

Note: standard errors in parentheses.
* $p<0.1$.
** $p<0.05$.
*** $p<0.001$.

## 4. Limits and critiques to DCE application in health sector

We have seen so far, the methodology, the application and the utility of discrete choice experiments, but we have not talked about DCE drawbacks. In this section we are going to focus on some of the critical points, raised by Bryan and Dolan[37], about DCE increasing use in health economics. The authors identify four specific weaknesses:

[37] Bryan, S. and Dolan, P. (2004).

a) Normative issues, related to how data from DCE studies might be used to inform policy. The discussion concerns "whose preferences about what are relevant to which policy". Bryan and Dolan conclude that DCE are more descriptive when applied to private health insurance schemes than to predominantly tax-based systems, such us in Italy and in most of the European countries. They highlight that many DCEs in health economics are conducted with specific patient groups, but they consider also non-health benefits. Moreover, they argue that, in order to inform policy decisions, the appropriate context would be a tax-based health care system, that would make all tax-payers implicitly be the most appropriate study group.

b) Psychological issues concerning the meaningfulness of the data generated, in particular about the effects that the process of elicitation itself have on constructing preferences. Moreover, they note that in many cases the very low response rates registered in DCE studies may depend on the "choice task" method, which presents some considerable cognitive challenges for respondents, who are often requested to process a large amount of information and consider too many tradeoffs between all the attributes.

c) Technical issues about how the data are generated and how robust they are. The authors point out as central issue that the number of discrete choices presented to respondents in DCE surveys is often too small compared with the total number of scenarios generated (usually eight or nine pairwise choices are reported in questionnaires, when the total number of possible scenarios range from 250 and 500). This would raise some doubts about the validity and the robustness of results obtained with this highly restrictive model. Moreover, they critique the approach used in many DCE studies with respondents with dominant preferences: these are commonly excluded from the analysis because they are not trading between the attributes. Bryan and Dolan claim that DCEs should include preferences of all respondents, such that the results of their analyses have relevance for policy decisions that affect all stakeholders.

d) Generalizability issues, i.e. how representative the sample of respondents, who undertake the experiment, are of the population that one wishes to generalize. DCEs results would be very context specific (factors such as geography and time are often constant in single data sources). Moreover, they would require the preference elicitation exercise to be repeated for each clinical setting or technology, before being appropriately extended outside the population from which they were estimated.

The authors, finally, conclude that more caution and circumspection towards DCE studies should be applied.

Lancsar and Donaldson[38] argue with the critiques moved by Bryan and Dolan saying that their conclusions do not invalidate DCE method per se. The critiques do not concern the theoretical or methodological basis of the experiments, but they only challenge the manner in which some DCEs have been applied in health economics so far.

However, the authors conclude that DCEs are not without limitations and several issues, about DCE approach in general, and health application specifically.

Hence, before applying choice experiments, it is needed a deep understanding of the theory, of the methods, and of how appropriately interpret the results.

[38] Lancsar, E. and Donaldson, C. (2005).

# III. DCE on Patients' Preferences in Kidney Transplantation

## 1. Introduction

In the last years, the University of Padova, has been conducting several studies and research projects in order to incorporate patients' preferences in a new algorithm in order to efficiently allocate organs. This research program particularly focuses on kidney transplantations, and already led to the realization of the paper "Eliciting Patients' Preferences in Kidney Transplantation: A Discrete Choice Experiment", (Genie, Nicolò and Pasini, 2017)[39]. In this chapter we are going to describe in detail the aim, the method and the results of this study, which were undertaken analyzing preferences of patients who are waiting for a kidney transplantation. In the following chapter, we will try to make our contribution considering data and preferences collected from patients already transplanted. The goal of both these papers is to study patients' time and risk preferences for kidney transplantation in Italy, and search for heterogeneity of tastes. We think that accounting for individual preferences in organ allocation can improve patients' satisfaction and the efficiency of algorithm matching kidney and recipient.

## 2. Background

Before entering the details of the research project and its results, we have to spend some words defining what transplantations, and in particular kidney transplantations, entail and how they are ruled and accomplished in Italy.

### 2.1 Transplantation

Organ transplantation is a surgical operation which consists in the substitution of a damaged organ, that cannot more fulfill its normal functions, with another one of the same kind that is taken from another individual, who is called donor. For the majority of organs, and in case of multi-organs transplantations, these are removed from a dead donor, but in the case of kidney

[39] Genie M., Nicolò A., Pasini G. (2017).

or liver transplantations the organs can derived also from living donors (it is possible to live normally with only a kidney or with a partial liver because this last has the ability to regenerate itself). Often transplantation is the only possible treatment that guarantees the patient to continue to live. Organs that have been successfully transplanted include the heart, kidneys, liver, lungs, pancreas, intestine, and thymus. Between those, heart, liver and lungs transplantations represent lifesaving surgeries, on the contrary, kidney transplantation is a valid therapeutic alternative for patients who have to be treated with dialysis otherwise. Dialysis is an effective procedure that performs many of the normal duties of the kidneys, like filtering waste products from the blood, but it often implies heavy effects on the body and requires several weekly sessions of three/four hours each.
On the other hand, organ transplantation is a very delicate intervention not only because of the surgical techniques that requires, which are almost perfectly refined, but also because of the ethical and psychological spheres involved.[40]

In 2016 Italy registered a record in organ transplants and donations, they have been over 400 more than those in 2015, reaching 3736 operations. This is the highest number observed in the country so far, with the highest increment compared with the previous year.

### 2.2 Waiting List and Allocation Protocols

When a potential donor is identified, all the procedures necessary to evaluate the effective eligibility are applied. Whether this process shows that the donation is possible, the selection of recipients begins and implies the identification of the patient, in the waiting list, who is the most suitable to receive that specific organ.
Waiting lists are a sort of rankings common to all healthcare services, included the most complex ones, such as organ transplantations. They are usually perceived by patients as a strong criticality in the system. The main reason for the need of waiting lists is an inadequate supply compared with the demand of services, or more specifically in this case, of organs. The main difference here is that in other healthcare sectors a structural, organizational, technological or professional improvement can consistently lower the waiting time. On the other hand, for patients who are waiting for an organ, this may not be sufficient, because the likely of transplantation is linked manly to the altruism and the solidarity of another person, the donor.

Currently in Italy all people, citizens or foreign, assisted by the *Servizio Sanitario Nazionale* (SSN) can be registered in the waiting list for transplantations. On the basis of national

[40] Trapianti.salute.gov.it. (2017). *Trapianti - Trapianto*.

indications, each transplantation center has to evaluate the clinical suitability of the candidates who participate in the program. For the adult recipients, the request of registration takes place through a unique Regional center, which gathers all the necessary personal, clinical and immunological data.[41]

As guarantee of the organ safety, there are some guidelines which define the levels of risk that are acceptable, and settle on the phases and the modalities in the risk evaluation process. More specifically the valuation about the donor suitability must depend on the following four points[42]:

• history of the patient;
• objective examination;
• instrumental and laboratory examinations;
• histopathological and/or autopsy examinations.

It is categorically forbidden organ transplantations from patients affected by:

• HIV-1 or HIV-2 seropositivity;
• HBsAg and HDV contemporary seropositivity;
• Malignant neoplasm in place (except for some specific exceptions);
• Systemic infections sustained by microorganisms against which there are no viable therapeutic options;
• Prion diseases ascertained.

In Italy the coordination of donations and transplantations develops on four different levels: a local level (Asl and Centri Trapianti), a regional level (Centri Regionali Trapianto), an interregional level (Centri Interregionali Trapianto), and a national level (Centro Nazionale Trapianto). The definition of the algorithm for organs allocation is assigned to regional or interregional levels, the criteria have to be common, transparent and scientifically valid, and the algorithm has to be approved by the Centro Nazionale Trapianto.[43] However, in all the regions the main criteria for kidney allocations are: blood group compatibility, histological compatibility, age, and time spent in waiting list.[44]

[41] Trapianti.salute.gov.it. (2017). Trapianti - Liste di attesa.
[42] Trapianti.salute.gov.it. (2017). *Trapianti* – DettaglioMenu
[43] Linee guida per la gestione delle liste di attesa Linee guida per la gestione delle liste di attesa e la assegnazione dei trapianto di rene da e la assegnazione dei trapianto di rene da donatore cadavere donatore cadavere. (n.d.). Centro Nazionale Trapianti.
[44] Il mattino di Padova (2017). .

It is important to report that this year, for the first time, there has been a reduction in the number of patients in Italian waiting list for kidney and lungs transplantations, in comparison with past years. Nevertheless, the lists remain still very long and the average waiting time is close to three years[45].

This is stimulating physicians to expand criteria of donor suitability (ECD) in order to transplant organs even when their characteristic are not optimal. In recent years the donor appropriateness criteria included older people, people with comorbidities (such as hypertension, diabetes, suboptimal renal functions) and individuals with risky behaviors which may potentially increase the risk of infectious disease transmission. It is still argued that, in many cases, discarded organs may be successfully transplanted, if the system for allocating them efficiently matched the right organ with the most appropriate recipient, in the right amount of time. Most allocation protocols are mainly based on the patients' waiting time on dialysis. Recipients are informed about the risk factors of the organ (and respective donor) they will receive, and they are requested to sign an informed consent.

In Veneto organs are allocated by the Interregional Reference Center (CIR) and the North Italy Transplant program (NITp), following the national guide lines. The allocation rules and criteria are periodically reviewed by CIR-NITp, and shared with regional centers, with transplantation centers and with CNT (National Transplantation Center). From a technical point of view, kidney allocation criteria are based on decreasing priority levels, the donor characteristics taken in consideration in the allocation algorithm are:

1) Blood group AB0
2) Type HLA-A, B, DRB1, DQB1
3) Age
4) Risk level;
5) Region that procures the donor

The receiver characteristics considered for kidneys allocation, instead, are:

1) Blood group AB0
2) Type HLA-A, B, DRB1
3) Transplant Center Region
4) Age
5) List waiting time (including dialysis time)

[45] Il Secolo d'Italia (2017).

6) PRA (Reactive Antibody Panel) and / or previous transplants

7) Possible presence of specific donor antibodies

8) Clinical urgency (absolute and relative);

9) Adherence to national programs provided by guidelines and protocols;

10) Combined transplant with other organs;

11) Entry to the PNI (National Hyperimmune Program) program.

In Northern Italy, the NITK4 algorithm has been defined in August 16th 2016. It is the current kidney allocation algorithm in Lombardia, Friuli-Venezia-Giulia, Liguria, Marche, Provincia Autonoma di Trento, and Veneto.[46]

The issue here is that the NITK4 algorithm takes in consideration almost only medical variables, and patients are rarely able to express their attitude on the kidney they would rather to accept. This organ allocation process is kindly automatic with little involvement from the candidates.

### 2.3 Valuation on quality of kidney transplantations in Italy (2000-2014)

The Ministero della Saluta provides periodically, through its website, a review of the data and the results relative to all the organs transplantations, and a valuation of all the Transplantation Centers in Italy[47]. In this section we will report only some statistics related to kidney transplantation relative to the period 2000-2014, but it is important to remind also data of 2015, with 1882 kidney transplantations, which are increased in 2016, reaching 2086 operations in Italy[48].

The upper part of the table "*Prospetto Italia*" (*Descrizione attività*) sums up the number of kidney transplantations accomplished yearly in Italy between 2000 and 2014. In the red circle we can see also the index of waiting list satisfaction, i.e. the ratio between the number of realized transplantations and the number of patients on the waiting list at that time. The following parts of this table give more information about the national results of kidney transplantations, splitting the number of both adult and pediatric cases by categories and complexity (*Case MIX*), and reporting the average percentage of patients and organs survivals between 2000 and 2014, and specifically in 2014 (*Risultati*).

Moreover, the graph in green shows the average percentages through the years of patient and organ survival an year after the operations in Italy. As we can observe in the graphs below,

[46] Ministero della Salute (2016). *6 Criteri di allogazione rene NITp*.

[47] Valutazione di qualità dell'attività del trapianto di Rene 2000-2014. (2016). Rete Nazionale Trapianti.

[48] Il fatto quotidiano. 2017/01/10.

both the results are slightly above the international percentage computed by CTS (Collaborative Transplant Study Europe) between 2000 and 2014.

The pie chart reports a valuation of the level of reintegration into a normal social activity for patients after kidney transplant: 92,7% of patients has a job or has the physical and psychological conditions to work. On the contrary, just a 2,6% cannot work because of diseases and only the 0,1% of patients is still in hospital during the follow-up period after the surgery.

Finally, the last table of this section describes the index of risk and complexity of operations, differentiating for donors' and recipients' characteristics. Red cells show that the relative Centro Trapianti has a higher risk than the national average, or that the cumulative risk of all the accomplished transplantations is higher than the national median. The characteristics taken in consideration to compute the risk indices are: both donor and recipient age, recipient weight, duration of dialysis treatments, ischemia time, diagnosis, complex cases, number of mismatch, thromboxanes (TX) precedents, transplant year, time spent in the waiting list, and Panel Reactive Antibody (Max PRA).

## Valutazione Qualità Rene: Tabella Prospetto ITALIA

### Descrizione Attività #

**Numero trapianti 2000-14 §: 23262**

| 2000-04 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 |
|---|---|---|---|---|---|---|---|---|---|---|
| 7448 | 1663 | 1660 | 1583 | 1531 | 1650 | 1512 | 1537 | 1590 | 1499 | 1589 |

### CASE-MIX #

| | Numero Casi Adulti Analizzati | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| N° casi Adulti 2000-14 §§ | Donatore età > 60 | Riceverte età > 50 | casi complessi | Combinati | Rene Doppio | Ischemia > 900 min. | N° casi Pediatrici §§ 2000-14 (**) | N° casi Combinati Adulti e Pediatrici | 2014 Indice Soddisfac. Lista* | 2001-2015 Attività Vivente |
| 19701 | 5722 | 9863 | 5445 | 991 | 1352 | 7732 | 826 | 1033 | 13,80% | 2549 |

### Risultati

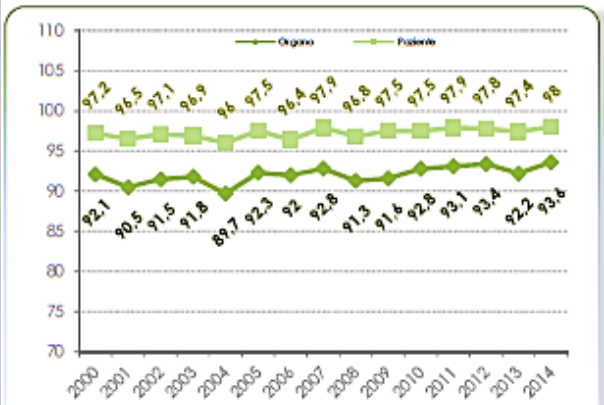
| | Casistica Adulti §§ 2000-14 | | | | Casistica Adulti §§ 2000-14 | | Casistica Adulti §§ Ultimo anno (2014) | | Casistica Globale §§ 2000-14 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Sopravvivenza Adulti | | | | Sopravvivenza Adulti | | Sopravvivenza Adulti | | Sopravv. Adulti/Ped. | |
| | Paziente | | Organo | | Paziente | Organo | Paziente | Organo | Paziente | Organo |
| | 1 anno (%) | Range | 1 anno (%) | Range | 5 anni (%) | 5 anni (%) | 1 anno (%) | 1 anno (%) | 1 anno (%) | 1 anno (%) |
| Italia | 97,2 | [90,0 - 97,4] | 92,1 | [89,4 - 92,1] | 92,1 | 82,1 | 98,0 | 93,6 | 97,3 | 92,1 |

### Risultati

| | Pediatrico (**) §§ 2000-14 | | | | Combinati 2000-14 | | Rene doppio 2000-14 | | Vivente 2001-2015 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Sopravv. | | | | Sopravv. | | Sopravv. | | Sopravv. | |
| | Paziente | | Organo | | Paziente | Organo | Paziente | Organo | Paziente | Organo |
| | 1 anno (%) | | 1 anno (%) | | 1 anno (%) | 1 anno (%) | 1 anno (%) | 1 anno (%) | 1 anno (%) | 1 anno (%) |
| Italia | 98,7 | | 91,1 | | 92,7 | 90,5 | 95,9 | 92,6 | 99,1 | 96,9 |

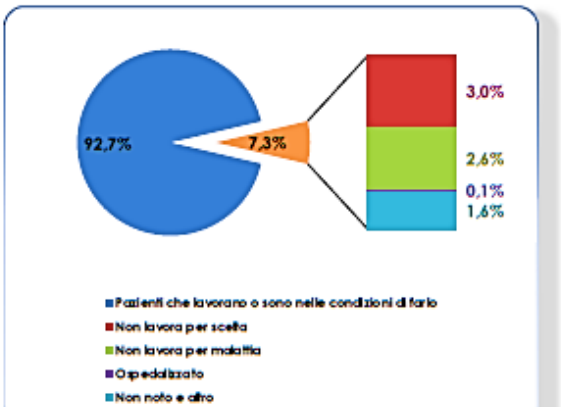
### Risultati negli anni

**Sopravvivenza Adulti Organo e Paziente ad un anno**




### Riabilitazione dei Pazienti

**Condizioni di vita sociale dei pazienti trapiantati (1)**




### Confronto con le Casistiche Internazionali

**Sopravvivenza dell'Organo ad un anno dal trapianto (%)**

| | |
|---|---|
| Italia(*) | 92,1 |
| CTS* | 91,2 |
| UK*** | 94 |

**Sopravvivenza del Paziente ad un anno dal trapianto (%)**

| | |
|---|---|
| Italia(*) | 97,3 |
| CTS* | 96,3 |
| UK*** | 96 |

(**) Il Trapianto pediatrico sarà anche oggetto di una valutazione degli esiti dedicata e specifica

***** Pari al rapporto tra il numero dei trapianti eseguiti e il numero di pazienti in Lista di Attesa**

§ sono inclusi i trapianti combinati e rene doppio §§ sono esclusi i trapianti combinati e rene doppio

(1) Informazione disponibile per l' 72,2% del campione dei trapianti su adulti effettuati nel periodo 2000-14

(*) Rene Singolo 2000-14

*Collaborative Transplant Study Europe 2000-14 ***UK 2011-2015,Adulti primo TX

# I dati sull'attività sono relativi ai Trapianti tracciati nei Report dei Centri Interregionali di Riferimento - I dati sul case-mix sono relativi alle schede di follow-up di cui si abbia tracciabilità nel Sistema Informativo Trapianti (SIT)

**Valutazione Qualità Rene: Tabella C* - Descrizione Complessità della Casistica per sopravvivenza organo**

| | # | Normalizzazione | | Complessità (Indici di Rischio **) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Donatore | Ricevente | | | | | | | | | | |
| | Numero Casi Adulti §§ 2000-14** N° casi | Effetto Centro aggiustato tramite statistica Bayesiana* | Effetto Centro da Cox *** | Età | Età | Peso | Tempo Dialisi | Tempo Ischemia | Diagnosi | Casi complessi | Numero Mismatch | TX Precedenti | Anno del Trapianto | Attesa in Lista | Max PRA |
| AN - A.O. TORRETTE - UMBERTO I | 327 | 0,01086 | -0,00335768 | 1,025 | 1,022 | 1,017 | 0,954 | 0,997 | 0,986 | 0,976 | 0,988 | 1,000 | 0,945 | 1,014 | 0,989 |
| AQ - OSPEDALE CIVILE S.SALVATORE | 432 | -0,007948 | -0,01873733 | 0,919 | 0,973 | 1,010 | 0,960 | 0,997 | 1,003 | 0,958 | 0,987 | 0,991 | 1,015 | 1,003 | 1,020 |
| BA - AZIENDA OSPEDALE POLICLINICO | 749 | -0,245 | -0,27305032 | 0,917 | 0,959 | 0,992 | 1,085 | 0,997 | 1,012 | 0,917 | 0,978 | 1,011 | 1,021 | 0,954 | 0,999 |
| BG - OSPEDALI RIUNITI - BERGAMO | 463 | 0,04132 | 0,03626846 | 0,934 | 0,972 | 0,998 | 1,053 | 0,997 | 0,993 | 0,991 | 1,003 | 0,996 | 0,991 | 0,950 | 0,994 |
| BO - S.ORSOLA-MALPIGHI | 894 | -0,1655 | -0,18090448 | 1,048 | 1,009 | 1,000 | 1,033 | 0,999 | 0,996 | 1,015 | 0,960 | 0,996 | 1,011 | 0,962 | 1,031 |
| BS - OSPEDALI CIVILI BRESCIA | 730 | -0,09923 | -0,11218253 | 1,000 | 1,014 | 0,997 | 1,035 | 0,995 | 0,994 | 0,997 | 1,007 | 1,001 | 1,001 | 0,958 | 1,001 |
| CA - A. O. G.BROTZU | 463 | 0,1446 | 0,15605934 | 0,914 | 1,004 | 0,972 | 0,996 | 0,997 | 1,011 | 1,005 | 1,032 | 0,993 | 0,976 | 1,013 | 1,006 |
| CS - A. O DI COSENZA | 159 | 0,1967 | 0,25420515 | 0,901 | 0,976 | 0,991 | 1,081 | 0,994 | 1,001 | 0,901 | 0,972 | 1,003 | 0,995 | 0,980 | 0,990 |
| CT - POL. UNIVERSITARIO | 492 | 0,497 | 0,55023537 | 0,969 | 0,974 | 1,039 | 0,994 | 1,002 | 0,983 | 0,903 | 1,022 | 0,994 | 0,990 | 1,043 | 0,981 |
| FI - AZIENDA OSPEDALIERA CAREGGI | 573 | 0,4835 | 0,53074868 | 1,094 | 1,019 | 1,010 | 0,956 | 1,023 | 1,004 | 0,979 | 0,999 | 0,997 | 1,020 | 1,037 | 0,980 |
| GE - AZ.OSP.S.MARTINO | 575 | -0,2284 | -0,2545714 | 0,992 | 1,003 | 1,004 | 1,012 | 1,001 | 0,989 | 1,099 | 1,006 | 1,004 | 0,997 | 0,980 | 1,001 |
| LE - A.O. VITO FAZZI | 41 | 0,1116 | 0,16171425 | 0,881 | 0,930 | 0,995 | 1,135 | 1,016 | 1,001 | 0,929 | 0,956 | 1,020 | 1,020 | 0,926 | 1,005 |
| MI - IRCCS S. RAFFAELE | 282 | 0,2648 | 0,30336399 | 1,031 | 1,033 | 1,002 | 0,990 | 0,997 | 1,041 | 1,014 | 1,026 | 1,001 | 0,986 | 0,986 | 0,993 |
| MI - MAGGIORE POLICLINICO | 683 | -0,1524 | -0,17323502 | 0,977 | 0,979 | 0,975 | 1,075 | 0,994 | 0,994 | 0,982 | 1,012 | 1,006 | 1,015 | 0,941 | 0,993 |
| MI - OSPEDALE CA GRANDA-NIGUARDA | 751 | -0,1521 | -0,16916773 | 0,997 | 1,008 | 0,989 | 1,001 | 0,991 | 0,984 | 1,023 | 1,019 | 1,001 | 1,024 | 0,967 | 1,002 |
| MO - POLICLINICO - MO | 360 | -0,00314 | -0,0146131 | 1,036 | 1,003 | 0,998 | 1,040 | 1,003 | 1,014 | 1,039 | 0,966 | 0,992 | 0,998 | 0,978 | 1,044 |
| NA - U.S. FEDERICO II | 478 | 0,8836 | 1,07956433 | 0,842 | 0,940 | 1,003 | 0,954 | 1,009 | 1,003 | 0,951 | 1,008 | 0,989 | 1,064 | 0,999 | 0,985 |
| NO - OSP. MAGGIORE DELLA CARITA' | 892 | -0,1766 | -0,19032815 | 1,075 | 1,030 | 0,997 | 0,975 | 1,016 | 1,005 | 1,051 | 0,955 | 1,007 | 1,002 | 1,030 | 1,008 |
| PA - ISMETT | 155 | 0,1527 | 0,18802253 | 1,004 | 1,035 | 0,987 | 1,074 | 1,014 | 0,994 | 1,013 | 1,030 | 1,002 | 0,949 | 0,999 | 0,986 |
| PA - OSP CIV.BENFRATELLI - M.ASCOLI | 574 | 0,3405 | 0,37188196 | 0,951 | 0,997 | 1,003 | 1,042 | 1,009 | 0,989 | 0,999 | 1,021 | 0,993 | 0,982 | 0,994 | 0,993 |
| PA - POLICLINICO UN.(P. GIACCONE) | 63 | 0,02459 | -0,05097753 | 0,886 | 0,964 | 0,984 | 1,218 | 1,011 | 1,000 | 0,986 | 1,045 | 0,987 | 1,103 | 0,983 | 0,977 |
| PD - AO - PEDIATRICO | 42 | 0,194 | 0,46101569 | 0,711 | 0,846 | 0,935 | 1,250 | 0,997 | 1,011 | 1,052 | 1,026 | 1,011 | 1,036 | 0,975 | 1,027 |
| PD - AZIENDA OSPEDALIERA DI PADOVA | 701 | -0,1261 | -0,14318196 | 1,045 | 0,996 | 1,002 | 0,971 | 0,993 | 0,998 | 0,997 | 1,022 | 1,002 | 0,990 | 1,005 | 0,998 |
| PG - AZIENDA OSPEDALIERA DI PERUGIA | 276 | 0,2792 | 0,32963015 | 0,976 | 1,014 | 1,012 | 0,960 | 1,015 | 0,999 | 0,974 | 0,972 | 0,994 | 1,028 | 1,024 | 0,976 |
| PI - AZIENDA OSPEDALIERA PISANA | 362 | -0,1097 | -0,13999553 | 1,018 | 0,976 | 0,994 | 0,986 | 0,997 | 1,054 | 1,036 | 0,996 | 1,004 | 1,016 | 1,036 | 0,983 |
| PR - OSPEDALI RIUNITI - (OSP.MAGGIORE) | 607 | -0,1628 | -0,18391373 | 1,023 | 1,000 | 0,990 | 1,034 | 0,998 | 1,028 | 1,029 | 0,963 | 0,999 | 1,012 | 0,973 | 1,038 |
| PV - S. MATTEO | 398 | 0,3521 | 0,3980788 | 1,000 | 0,997 | 1,015 | 0,966 | 0,996 | 0,992 | 1,007 | 1,021 | 0,998 | 0,998 | 1,001 | 0,993 |
| RC - AZ.OSP.BIANCHI M MORELLI | 195 | 0,3372 | 0,44195154 | 0,873 | 0,937 | 0,983 | 1,052 | 0,996 | 0,998 | 0,919 | 0,986 | 0,995 | 0,998 | 0,980 | 0,991 |
| RM - AZ.OSP.SAN CAMILLO-FORLANINI | 227 | 0,0156 | -0,00665278 | 0,978 | 0,994 | 1,004 | 0,996 | 1,011 | 1,013 | 0,942 | 1,016 | 1,003 | 0,919 | 1,036 | 1,029 |
| RM - AZ. OSP. UNIV. POLICLINICO TOR VERGATA | 480 | 0,2677 | 0,29781029 | 0,940 | 0,984 | 0,991 | 1,029 | 0,994 | 0,994 | 1,083 | 1,029 | 0,999 | 1,017 | 0,971 | 1,020 |
| RM - AZIENDA POLICLINICO UMBERTO I | 508 | -0,06289 | -0,0808511 | 1,008 | 0,996 | 1,002 | 0,991 | 0,998 | 1,007 | 0,938 | 1,036 | 0,997 | 1,001 | 1,021 | 0,992 |
| RM - OSPEDALE PED. BAMBINO GESU | 32 | 0,2107 | 0,67197463 | 0,662 | 0,846 | 0,933 | 0,985 | 1,008 | 1,043 | 0,962 | 0,992 | 1,036 | 1,001 | 0,985 | 1,087 |
| RM - POLICLINICO A. GEMELLI E C.I.C. | 461 | -0,1075 | -0,13496409 | 0,943 | 0,984 | 0,991 | 0,998 | 0,993 | 1,006 | 0,958 | 1,029 | 0,998 | 1,005 | 1,012 | 1,006 |
| SA - OORR S.GIOVANNI DI DIO E RUGGI D'ARAGONA | 221 | -0,06086 | -0,13210335 | 0,893 | 0,979 | 1,014 | 0,892 | 1,002 | 0,995 | 0,948 | 0,981 | 0,992 | 0,906 | 1,018 | 0,984 |
| SI - SPEDALI RIUNITI (POL. LE SCOTTE) | 597 | 0,4734 | 0,51359914 | 1,091 | 1,009 | 1,009 | 0,949 | 0,996 | 0,998 | 1,025 | 0,989 | 1,006 | 0,991 | 1,046 | 0,983 |
| SS - S.S. ANNUNZIATA SASSARI | 163 | 0,04416 | 0,03345092 | 0,907 | 0,999 | 0,976 | 0,911 | 0,994 | 0,991 | 0,999 | 1,047 | 0,988 | 1,075 | 1,044 | 0,982 |
| TO - A. O. S.GIOVANNI B. DI TORINO | 1390 | -0,1454 | -0,15387212 | 1,103 | 1,045 | 0,988 | 1,008 | 1,006 | 1,009 | 1,054 | 0,958 | 1,014 | 0,986 | 1,028 | 1,009 |
| TO - OSPEDALE REGINA MARGHERITA | 4 | 0,1333 | 2,65376476 | 0,630 | 0,846 | 0,932 | 0,811 | 0,996 | 1,036 | 0,986 | 0,952 | 1,038 | 0,919 | 1,062 | 0,975 |
| TV - OSPEDALE CA FONCELLO | 652 | 0,1043 | 0,10682531 | 1,006 | 0,989 | 1,013 | 0,976 | 0,990 | 0,995 | 0,969 | 1,020 | 1,002 | 1,013 | 1,008 | 0,997 |
| UD - A.O. S.MARIA DELLA MISERICORDIA | 557 | -0,09705 | -0,11679051 | 1,022 | 1,018 | 1,025 | 0,951 | 1,003 | 0,989 | 1,055 | 1,014 | 0,992 | 0,994 | 1,044 | 0,986 |
| VA - OSPEDALE. FONDAZIONE MACCHI | 600 | 0,1524 | 0,15992444 | 1,033 | 1,032 | 1,004 | 0,979 | 0,988 | 0,994 | 0,971 | 1,024 | 0,993 | 1,008 | 0,982 | 0,984 |
| VI - OSPEDALE DI VICENZA | 403 | 0,1301 | 0,13903821 | 0,991 | 0,986 | 1,007 | 0,984 | 0,991 | 0,975 | 0,985 | 1,014 | 0,994 | 1,009 | 1,015 | 0,988 |
| VR - AZIENDA OSPEDALIERA DI VERONA | 689 | -0,4573 | -0,50275824 | 1,018 | 1,005 | 1,008 | 0,945 | 1,001 | 0,987 | 1,027 | 1,018 | 0,997 | 0,972 | 1,027 | 0,994 |
| **ITALIA** | **19701** | | | | | | | | | | | | | | |

§ sono inclusi i trapianti combinati e rene doppio §§ sono esclusi i trapianti combinati e rene doppio

# I dati sull'attività non sono relativi ai Trapianti effettivamente eseguiti ma alle schede di follow-up di cui si abbia tracciabilità nel Sistema Informativo Trapianti (SIT)

* La Tabella A, la Tabella B e la Tabella C sono da considerarsi pubblicabili se insieme ed in forma integrale

** Viene assegnata una qualità se il centro ha un rischio superiore alla media nazionale o se il rischio cumulato su tutti i trapianti effettuati è superiore alla mediana nazionale

*** Stima dell'HR (effetto centro) per ciascun centro tramite il modello di Cox

* Stima dell'effetto centro aggiustato tramite statistica bayesiana al fine di approssimare ad un normale la distribuzione degli HR dei diversi centri

### 2.4 The contribution and statistics from *Centro Trapianti di Padova.*

The Azienda Ospedaliera di Padova is the national leaders in kidney transplantations, 161 kidney transplantations have been accomplished in 2016, reaching 2050 operations of this kind for the Centro Trapianti di Padova. Fifty operations in 2016 have involved living donors, placing Padova as the first in Italy.

Living donors are a resource that can be implemented in order to cope with organ deficiency. The Centro di Padova has adopted state-of-the-art surgical techniques, such as kidney removal with laparoscopy, innovative pharmacological and aferhetic therapies to carry out transplantation, even in the presence of blood group incompatibilities. Since 2010, more sophisticated desensitization methods have been applied allowing for 57 transplants to be performed despite AB0 blood donor and recipient incompatibility. While in the past the incompatibility of the blood group was considered an absolute contraindication to the transplant, these procedures allowed to proceed with transplantation with good results, increasing the number of donations. Padua has also become a reference center for teaching, to surgeons from all over Italy, laparoscopic technique for nephrectomy in the living donor.[49]

## 3. Eliciting preferences of patients in waiting list for kidney transplantation

As we anticipated, this study is based on the evidence that often patients' preferences have been largely ignored in kidney allocation algorithm. Moreover, kidney transplantations have dialysis as effective alternative, against which candidates on the waiting list can balance risks and preferences. Hence, depending on personal, social, cultural and economic status, or on other unobservable characteristics, recipients may have different preferences for the attributes of the kidneys candidate for the transplantation. Some of them could prefer to wait for a longer time in order to receive the "optimal kidney", others would rather to accept as soon as possible the organ, even if it has not all the ideal qualities. Preferences, then, may have a key role for optimal matching and for the maximization of welfare to the patients, this paper aims to investigate with particular attention heterogeneity in those. This study is the first to apply DCE to estimate candidates' time and risk preferences in kidney transplantations through a mixed logit model. Moreover, it estimates patients' Willingness to Wait (WTW) for changes in each transplant attribute level.

[49] Il mattino Padova. 2017/02/22

### 3.1 Attributes selection and experimental design

Genie, Nicolò and Pasini applied a discrete choice experiment to elicit patients' preferences at Kidney and Pancreas Transplantation Unit of the Department of Surgery and Organ Transplantation, University of Padova.

In consultation with kidney surgeons and nephrologists of the Ospedale di Padova, the authors selected four attributes: Waiting Time, Expected Graft Survival, Infectious Risk, Neoplastic Risk.

Waiting time is determined by recipient's characteristics and by the supply of kidneys of a certain type, and it is associated with four different levels.

Expected graft survival depends on the characteristics of the organ itself and on the compatibility between recipient and donor. It works like a measure of how long the organ is expected to function, but it is subject to a certain degree of uncertainty. In this study, it has three possible levels.

Infectious risk and neoplastic risk can be "Standard" or "Augmented". Standard risk, which is the most frequent one, includes cases for which the evaluation process did not identify any risk factor for transmittable diseases. This case does not exclude at all infectious or neoplastic pathologies, which may still be transmitted even if guidelines and good clinical practice are followed. Augmented risk describes cases in which the transplanted kidney has an increased risk of transmission of infectious and neoplastic diseases. It is usually justified by the urgency of a particular clinical status, and it is combined with an appropriate prophylactic therapy.

Table 7 summarizes the attributes, with the respective definition, and the levels chosen for each attribute.

Table 7: Attributes, definition and levels [39]

| Attributes | Definition | Levels |
|---|---|---|
| Waiting Time | The number of months one has to wait in order to obtain the proposed transplant | 6, 12, 36, 60 months |
| Expected Graft Survival | The expected length of time the kidney functions well enough to keep recipients from either needing initiation (or return to) dialysis, or another transplant | 10, 15, 20 years |
| Infectious Risk | The risk of contracting infectious disease through the transplanted organ | Standard<br>Augmented |
| Neoplastic Risk | The risk of contracting a tumor through the transplanted organ | Standard<br>Augmented |

A full factorial design, here, would give rise to 48 possible scenarios (2*2*3*4), which can be then combined into 1128 potential choices. Because of the reasons we analyzed above, about too long questionnaires and possible cognitive problems, the authors preferred a fractional factorial approach generating 16 choice sets. The design was realized with AlgDesign Package in R, in order to identify a pseudo-optimal design: dominant alternatives are here excluded, choice sets are not repeated, transitivity and monotonicity axioms are utilized in order to minimize the number of choice sets for which the answer can be inferred from a previous one. In each choice set, patients have been asked to choose between two alternative treatments, reported with the generic labels "Treatment A" and "Treatment B", for kidney transplantations, each of those with different characteristics. It is possible to see an example of choice set below. We can notice that neither status-quo option (i.e. dialysis treatment) nor opt-out options are included.

Figure 14: An example of Kidney Transplant Choice: Which treatment would you prefer? (put an X below the chosen treatment)

| | **Treatment A** | **Treatment B** |
|---|---|---|
| Waiting Time | 36 months | 6 months |
| Graft Survival | 15 years | 10 years |
| Infectious Risk | Standard | Augmented |
| Neoplastic Risk | Augmented | Augmented |
| Your Choice | ☐ | ☐ |

### 3.2 Questionnaire, Data and Pilot test

The questionnaire also includes some demographic, personal and psychological characteristics of recipients used to estimate their impact on time and risk preferences of the individuals. These are:

- Education;
- Composition of the family;
- Number of son/daughters;
- Job and career;
- If the subject receives an invalidity pension;
- A group of questions describing the psychological status of the patient;
- A group of questions describing the quality of life perceived by the patient.

A pilot test with 16 choice sets has been conducted taking students as subjects, and no fatigue effect was found.

The data of the final experiment have been collected through face-to-face interviews conducted by a psychologist appropriately trained to expose the project and explain the attributes and the levels, used in the DCE, in order to minimize possible cognitive problems. This approach led to obtain a response rate close to 100%.

The interviews have taken place from April 14, 2005 to February 8, 2017. The sample is the entire population of patients on the waiting list of the kidney and pancreas transplantation unit in Padova. As we saw above, the Centro Trapianti di Padova is one of the biggest in Italy, and it is comparable with other transplant centers in and outside the country.

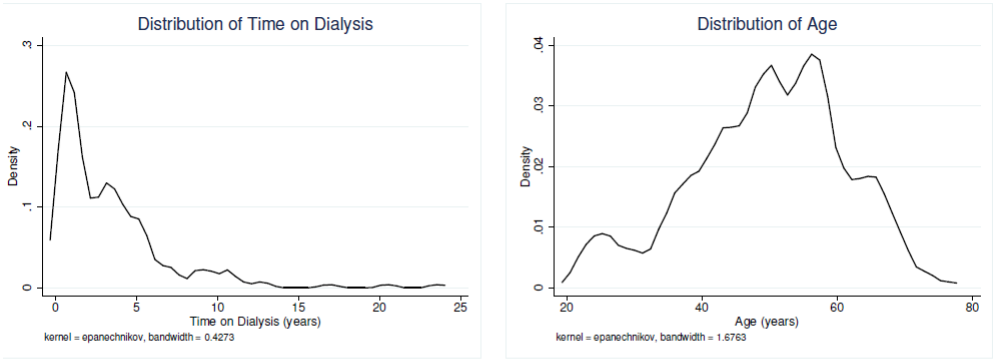
A total of 250 patients on the waiting list have been interviewed, out of them, 248 completed the discrete choice sets. Data from these 248 candidates are, then, considered in the final analysis.

Analyzing the data , the authors observed that, as shown in Table 8, the average time spent on dialysis is more than three years, comparable with the national average of 2.8 years, and the average age of patients is about 50 years.

The authors used the Kernel density plot for the distributions of the covariates: Figure 15a shows a large variation in time spent on dialysis. It is left-skewed with a strong concentration between 0.005 and 5 years. Figure 15b represents the variation in age across the candidates, the distribution is right-skewed but almost symmetric, and the center is around 50 of age.

Table 8: Characteristics of Transplant Candidates[39]

| Variable | Mean | SD | Min | Max |
|---|---|---|---|---|
| Age | 49.9 | 11.52 | 21 | 76 |
| Time on Dialysis | 3.395 | 3.63 | 0.005 | 23.617 |




(a) Time on Dialysis (b) Age

Figure 15: Kernel plots of the distribution of covariates[39]

### 3.3 Estimation method and general results

As we have seen in the previous DCE, the authors use random utility models to capture heterogeneity in patients' preferences and, as suggested by McFadden and Train (2000), they decided to estimate the model with a mixed logit.

The predictable component of the overall utility that candidate *m* derives from choosing treatment *t* on choice set *s*, given unlabeled alternatives is:

$$V_{mst} = \beta_{1,m} Time_{mst} + \beta_{2,m} Survival_{mst} + \beta_{3,m} Infectious_{mst} + \beta_{4,m} Neoplastic_{mst}$$

where $Time$ is the waiting time attribute, $Survival$ refers to the expected graft survival, $Infectious$ and $Neoplastic$ are respectively the infectious and the neoplastic binary variable, they are equal to 1 if the relative risk is standard, and zero otherwise.

Moreover the authors use the waiting time attribute to compute an estimate of the "willingness to wait" (WTW) of patient *m* for each other attribute. This index shows the relative importance that a patient gives to each attribute in terms of waiting time (in months) for kidney transplantations.

$$WTW_m = -\frac{\beta_{k,m}}{\beta_{1,m}}$$

Analyzing the results reported in Column 1 of Table 9 we can notice that patients exhibit a substantial amount of heterogeneity in preferences. The coefficients for all the attributes analyzed result significant at 1% level and they have the expected signs: patients prefer shorter waiting time, longer expected graft survival and standard infectious and neoplastic risks over augmented ones.

Column 3 summarizes the estimates of the mean willingness to wait for each attribute. It is shown that, on average, patients are willing to wait about six months for an extra year in the expectation of graft survival, 29 months to have a standard infectious risk, and 30 months for a standard neoplastic risk. In order to investigate the entire distribution of individuals, the authors use the kernel density plot to represent the individual WTW derived from the mixed logit model. From Figure 16 we notice that the distributions of individual WTW have different shapes for the attributes considered:

- the distribution of WTW for an extra year of graft survival shows large preference heterogeneity, and a concentration at about 5 months. By the way, it has a long right tail, meaning that a consistent fraction of patients would wait even longer that the mean.
- the distributions in Figure 16b and 16c are less concentreted and show an higher heterogeneity in patients preferences about standard risk attributes.

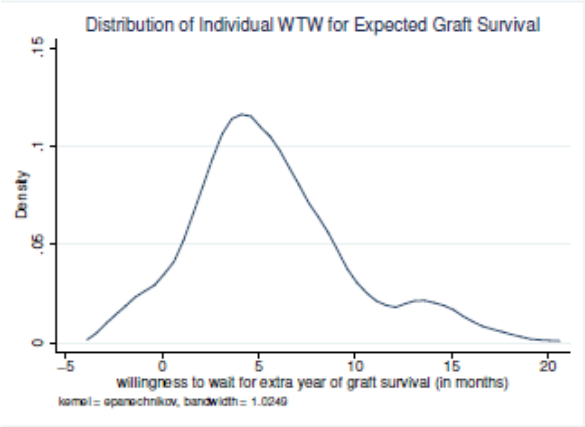
Table 9: Mixed Logit Models with Normally Distributed Coefficients and WTW Estimates [39]

| | (1) (Mean) M1 | (2) (SD) M1 | (3) (WTW) M1 | (4) (Mean) M2 | (5) (SD) M2 | (6) (WTW) M2 |
|---|---|---|---|---|---|---|
| Waiting time | -0.0539*** | | | -0.0659*** | 0.0590*** | |
| | (0.00300) | | | (0.00524) | (0.00474) | |
| Graft survival | 0.308*** | 0.292*** | 5.722*** | 0.355*** | 0.225*** | 5.391*** |
| | (0.0320) | (0.0268) | (0.469) | (0.0315) | (0.0372) | (0.471) |
| Standard infectious risk | 1.542*** | 1.457*** | 28.61*** | 1.701*** | -1.231*** | 25.83*** |
| | (0.127) | (0.105) | (2.055) | (0.124) | (0.110) | (2.188) |
| Standard neoplastic risk | 1.598*** | 1.274*** | 29.66*** | 1.826*** | -1.277*** | 27.73*** |
| | (0.133) | (0.123) | (2.090) | (0.143) | (0.137) | (2.408) |
| cons | 0.171*** | | | 0.170*** | | |
| | (0.0435) | | | (0.0472) | | |
| *Observations* | 7636 | | 7636 | 7636 | | 7636 |
| *Candidates* | 248 | | 248 | 248 | | 248 |
| *Loglikelihood* | -2169.24 | | | -2042.69 | | |
| $Mcfadden - R2$ | 0.1019 | | | 0.1543 | | |

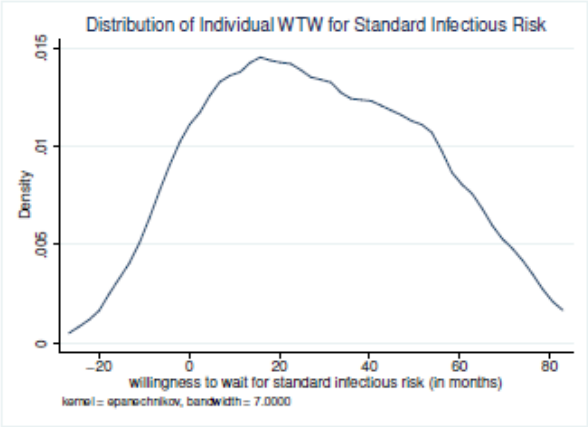
Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

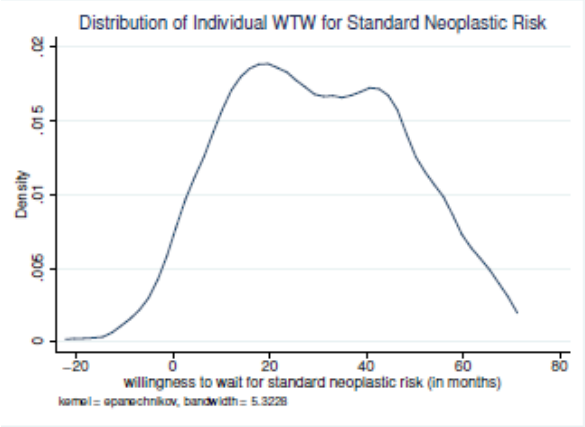
[a] Dependent variable is equal to one for the chosen alternative and zero otherwise. M1 is the mixed logit model with 'waiting time' fixed, and M2 is the mixed logit model with all the attributes being random.




(a) WTW for extra year of survival




(b) WTW for standard infectious risk




(c) WTW for standard neoplastic risk

Figure 16: Kernel plots of the distribution of individual WTW for the whole population [39]

We can conclude that the change in levels of the attributes varies across patients for unobserved reasons, this gives space for further analysis in order to identify covariates that may drive differences in WTW.

For this reasons the authors broke down the analysis for differences in the time spent on dialysis, and for different age groups. The relevant results are reported in the following sections.

### 3.4 Further Analyses: Estimation Results and WTW by Time on Dialysis

Patients with irreversible chronic kidney problems, and without preemptive transplantation, need a dialysis therapy while they are waiting for kidney transplantation.

Currently the kidney allocation algorithm is, mainly, on first-come first-transplanted basis, i.e. the available organ is offered to the patient who has spent longer time on the waiting list, without considering that there may be patients who are willing to wait longer than others for a better quality kidney. Moreover patients who have spent longer time on dialysis have the precedence in receiving the organ, even if other patients may obtain greater health benefits from transplantation.

The authors split the sample into two groups in order to identify possible variations in patients' WTW according to how long they are undergoing the dialysis therapy: patients above the median, and patients below the median. Table 10 summarizes the results and the WTW estimates of the two groups. All the coefficients are significant at the conventional levels, and they have the expected signs for both groups. The most interesting finding is that there is evidence that patients with relatively longer time on dialysis are willing to wait longer than other patients for better quality kidneys, and this difference is statistically significant for all the attributes.

Table 10: Mixed Logit Model result- by Time on Dialysis [39]

| | (1) (Mean) M1 | (2) (SD) M1 | (3) (WTW) M1 | (4) (Mean) M2 | (5) (SD) M2 | (6) (WTW) M2 | (7) (D/ce-WTW) t-ratio |
|---|---|---|---|---|---|---|---|
| Waiting time | -0.0610*** | | | -0.0469*** | | | |
| | (0.00442) | | | (0.00408) | | | |
| Graft survival | 0.286*** | 0.253*** | 4.695*** | 0.322*** | 0.307*** | 6.877*** | 2.275** |
| | (0.0424) | (0.0363) | (0.550) | (0.0466) | (0.0388) | (0.786) | |
| Standard infectious | 1.419*** | 1.417*** | 23.26*** | 1.683*** | 1.453*** | 35.90*** | 2.92*** |
| | (0.176) | (0.139) | (2.479) | (0.184) | (0.152) | (3.543) | |
| Standard neoplastic | 1.551*** | 1.190*** | 25.42*** | 1.683*** | 1.297*** | 35.89*** | 2.39** |
| | (0.184) | (0.171) | (2.495) | (0.194) | (0.169) | (3.601) | |
| cons | 0.250*** | | | 0.0977 | | | |
| | (0.0617) | | | (0.0617) | | | |
| *Observations* | 3822 | | 3822 | 3814 | | 3814 | |
| *Loglikelihood* | -1074.14 | | | -1081.68 | | | |

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

[a] M1 is the mixed logit model for candidates with shorter time on dialysis, and M2 is the mixed logit model for candidates with relatively longer time on dialysis.

### 3.5 Further Analysis: Estimation Results and WTW by Age

The authors investigated also coefficients and WTW for attributes of kidney transplant according to recipients' age, defining three different groups: age 21-45, age 46-56 and 57-76. Table 11 summarizes the results obtained with mixed logit models: we can notice that coefficients vary among the different age-groups. There is evidence that younger patients are willing to wait longer for better levels of the others three attributes than recipients in the last quantiles (56+), and the difference in statistically significant, and older patients have shorter WTW, for all the attributes, than other subjects.

Table 11: Mixed Logit Model Result by Age [39]

| | (1) (Mixed Logit) 21-45 | (2) (WTW) 21-45 | (3) (Mixed Logit) 46-56 | (4) (WTW) 46-56 | (5) (Mixed Logit) 57-76 | (6) (WTW) 57-76 |
|---|---|---|---|---|---|---|
| **Mean** | | | | | | |
| Waiting time | -0.0408*** | | -0.0526*** | | -0.0792*** | |
| | (0.00455) | | (0.00476) | | (0.00738) | |
| Graft survival | 0.281*** | 6.893*** | 0.343*** | 6.533*** | 0.308*** | 3.883*** |
| | (0.0491) | (0.910) | (0.0500) | (0.728) | (0.0729) | (0.779) |
| Standard infectious | 1.445*** | 35.43*** | 1.645*** | 31.30*** | 1.595*** | 20.14*** |
| | (0.202) | (4.518) | (0.197) | (3.284) | (0.280) | (3.011) |
| Standard neoplastic | 1.379*** | 33.80*** | 1.801*** | 34.26*** | 1.779*** | 22.46*** |
| | (0.207) | (4.401) | (0.222) | (3.615) | (0.297) | (3.092) |
| cons | 0.170** | | 0.119* | | 0.239*** | |
| | (0.0710) | | (0.0700) | | (0.0910) | |
| *Observations* | 2638 | 2638 | 2888 | 2888 | 2110 | 2110 |
| *Loglikelihood* | -770.66 | | -817.41 | | -559.41 | |

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

### 3.6 Conclusion

The mixed logit results confirm the presence of preferences' heterogeneity for all the attributes considered. Moreover the authors observe significant differences in WTW for the changes in levels of kidney transplant attributes according to age and the time spent on dialysis: patients who spent longer time on waiting list (and, hence, on dialysis too) are willing to wait longer for a better quality kidney than other candidates, and younger patients are, on average, willing to wait longer than older candidates.

The most important achievement of this study is that it recognizes differences in individual preferences for kidney allocation and willingness to wait. The results of this paper might be used to adjust the organ allocation algorithm in order to improve recipients' satisfaction and general welfare of patients.

# IV. Econometrical analysis: DCE eliciting preferences of patients after kidney transplantation

## 1. Introduction

In these last sections we are going to deepen the study of the University of Padova about the patients' preferences in kidney transplantations, seen in the previous chapter.
In Genie, Nicolò, Pasini (2017) respondents were asked to choose between different treatments for themselves. Even if the authors control the results for recipients' individual characteristics, it can be argued that the preferences obtained from this DCE may be affected by some sources of bias due to recipients' unobservable personal experiences. The literature suggests that also cognitive distortions, such as optimism[50] or pessimism[51] biases, may have driven recipients' choices and preferences. For instance, we know that optimism bias causes a person to believe that he/she is at a lesser risk of experiencing a negative event compared to others[52]. It usually transcends gender, nationality and age and it is quite a common source of bias in health economics: for example, there is evidence that smokers believes that they are less likely to contract lung cancer or disease than other smokers[53].

In order to investigate patients' time, survival and risk preferences, and search for heterogeneity of tastes, we conducted a new DCE utilizing an expedient to avoid bias due to these cognitive distortions and to recipients' personal experiences. We conducted a discrete choice experiment among patients who already received kidney transplantation, and asked them, not to make their choices for themselves, but to advice a fictional individual: Antonio, a 45 years old patient, waiting for kidney transplantation. The respondents have to take in consideration some other personal characteristics of this imaginary patient, in order to formulate their advice with a complete set of information: Antonio has been on dialysis since two years and a half ago, and waiting for kidney transplantation for one year and a half. He is

[50] McKenna, F. (1993).
[51] Shepperd, J. A., Patrick Carroll, et al. (2002).
[52] O'Sullivan, Owen P. (2015).
[53] Weinstein, N. (2005).

married and has two children. Antonio obtained a high-school diploma and now he is an office-worker. Apart from kidney diseases, Antonio is in good health.

By the expedient of choosing for another individual, we want to clear results by eventual sources of cognitive bias. By fixing the personal characteristics of the same fictional individual to all the respondents, we want to investigate the heterogeneity of tastes, highlighting intrinsic individual preferences .We think that the organ allocation algorithm should account for these individual tastes, in order to improve patients' satisfaction and the efficiency of the set of rules matching kidney and recipient.

The discrete choice experiment described in the following pages is based on the same information, methodology and the background described in Chapter III.

## 1. Experimental design and questionnaire

In this DCE we used the same attributes (Waiting Time, Expected Graft Survival, Infectious Risk, Neoplastic Risk) and levels used in Genie, Nicolò, Pasini's study, and the same experimental design[54]: fractional factorial approach composed by the 16 choice sets included also in the previous DCE. These are composed by two alternatives each, and labelled with the generic names "Treatment A" and "Treatment B". As in the previous questionnaire, no opt-out nor status-quo options are included, we know from the literature that not considering these options in the choice sets can cause problems in preferences identification. For instance, a respondent could be not satisfied by neither Treatment A nor Treatment B in a specific choice set and, instead, be willing to wait longer on dialysis in order to receive a better organ. Despite of that, in these studies, it has been chosen to include neither of these options in order to force respondents to take a decision, even when the choice would require more time. This strategy has been implemented, mainly, in order to gather a higher number of data and a more complete set of information.

We remind that the design has been realized with AlgDesign Package in R, which excluded dominant alternatives and repetition of choice sets, and took into account transitivity and monotonicity axioms in order to minimize the number of choice sets for which the answer can be inferred from a previous one.

Besides the choice sets, the questionnaire, as the one described in the previous chapter, asks some demographic, personal and psychological characteristics of respondents: education,

[54] See Table 7

composition of the family, number of son/daughters, job and career, if the subject receives an invalidity pension, the psychological status of the patient, and the quality of life perceived by the patient. The original text of the questionnaire is reported in Appendix C.
Moreover, from medical records, we could obtain information about gender, age, and date of transplantation for each respondents.

Finally, the questionnaire includes three mathematical questions, in order to check candidates' cognitive and logic abilities. By the way, we consider these measures not very reliable: respondents answered the questionnaire at their own place, so we cannot exclude that those who scored a high result have received some sort of help in mathematical computation. Moreover, it would be a too strong assumption to think that mathematical abilities can be approximated with ability to value own preferences. Hence, we found no reasons to exclude from our analyses patients' preferences on the basis of their scores to these sections, even if they obtained a low or zero score.

## 2. Sample and data collection

The sample is defined among a selected population of patients who have received kidney transplantation at the Kidney and Pancreas Transplantation Unit in Padova in the period from 1988, date of the first kidney transplantation in this Transplantation Center, to 2015. The sample was selected between those who had the periodical medical examination and check-up in the period between May 28, 2015 and the end of the same year. The questionnaires have been sent by post in the first months of 2015 to patients who had the examination scheduled in the period described above. The respondents have been asked to return the completed question by hand to their physician at the Kidney and Pancreas Transplantation Unit in Padova.
549 questionnaires have been sent, out of these, 330 came back: 248 entirely or partially completed, and 82 not filled in. 196 questionnaires have never been brought back and 23 have never been delivered by post. Hence, 248 candidates are considered in the final analysis, with a response rate equal to 45,17%. If the candidates answered completely the questionnaire we would have 7936 (248*32) observations for patients' preferences about attributes and levels, but, as we said above, some questionnaires are just partially filled in, hence we have been able to collect a total of 7780 observations. This is a quite good result for a postal survey without incentives, and it can gives us an idea about perception of this topic as something important and valuable to the patients.

From a very preliminary analysis of the data we can observe that our sample is composed by 152 male respondents (62%), 93 females (38%) and three patients for who this data was not available. Out of male individuals, the mean age is equal to 57 years, and for women this data is equal to 51. The mean age of the total sample is equal to 55 years and it varies from 22 to 80 years old respondents. Table 12 summarizes these information and the relatives standard deviations and ranges.

Moreover, we reported in Figure 17 the Kernel density plot for the distribution of respondents' age. This distribution is almost symmetric, even if slightly right-skewed, and it is centered at around 55 years of age.

Table 12: Characteristics of the Sample

| Variables: | N° Obs. | Mean Age | SD (Age) | Min Age | Max Age |
|---|---|---|---|---|---|
| Males | 152 | 57 | 11.862 | 30 | 80 |
| Females | 93 | 51 | 11.855 | 22 | 74 |
| Total | 248 | 55 | 12.211 | 22 | 80 |

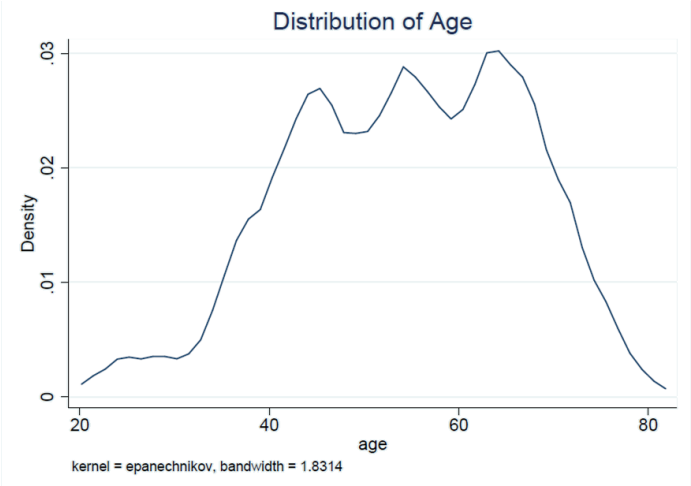



Figure 17: Kernel plot of the distribution of Respondents' Age

## 3. Estimation method and general results

In order to make our results coherent and comparable with those obtained by Genie, Nicolò, Pasini, and as suggested by DCE literature, we decided to use a mixed logit model to estimate our results and to capture heterogeneity in transplanted patients' preferences.

We have to remind that, in this study, patients are not asked to decide for themselves, but to advise a fictional recipient with fixed characteristics. In this way we should exclude heterogeneity due to recipient's observable characteristics and we should be able to capture

unobservable heterogeneity just due to differences in intrinsic preferences of transplanted respondents.

As in the study analyzed in the previous chapter, we defined the predictable component of the utility that candidate *m* derives from choosing treatment *t* on choice set *s*, as:

$$V_{mst} = \beta_{1,m} Time_{mst} + \beta_{2,m} Survival_{mst} + \beta_{3,m} Infectious_{mst} + \beta_{4,m} Neoplastic_{mst}$$

with $Time$ as the waiting time attribute, which is set as fixed, $Survival$ as the expected graft survival, $Infectious$ and $Neoplastic$, respectively, as the infectious and the neoplastic binary variables, which are equal to 1 if the relative risk is standard and zero if it is augmented. The dependent variable is equal to one for the chosen alternative and zero otherwise.

We also computed, as specified in Chapter III, patients' willingness to wait (in months) for each attributes considered in the model, in order to compare these results with those obtained by patients still on the waiting lists.

Table 13 summarizes the results obtained by our regression (M1) and reports the results obtained by Genie, Nicolò, Pasini in the grey part of the table (M2) for comparison. We notice that also transplanted patients exhibit a substantial amount of heterogeneity in preferences. All the coefficients are significant at 1% level and they have the expected signs. As predictable, also transplanted patients prefer shorter waiting time, longer expected graft survival, and standard infectious and neoplastic risks. Transplanted patients are shown to be willing to wait almost 29 months to have a standard infectious risk (such as patients on waiting list), 5 months for an extra year in the expectation of graft survival (rather than 6 months for patients on the waiting list), and 34 months for a standard neoplastic risk (rather than 30 for patients on waiting list). By the way, the difference between WTW of transplanted patients and patients on waiting list, is not significantly different from 0, at the 95% confidence level. All the t-tests between the corresponding WTW give a t-ratio included between -1.96 and 1.96, meaning that the null hypothesis is accepted.

In Figure 18 we reported kernel density plots for the individual WTW for each attribute, derived from the mixed logit model. The distribution of WTW for an extra year of graft survival shows a concentration at about 4 months, and it has a long right tail, meaning that a consistent fraction of patients would wait even longer that the mean. The distributions for risk attributes (here such as in Genie, Nicolò, Pasini's study) are less concentreted and show an higher heterogeneity in patients preferences.

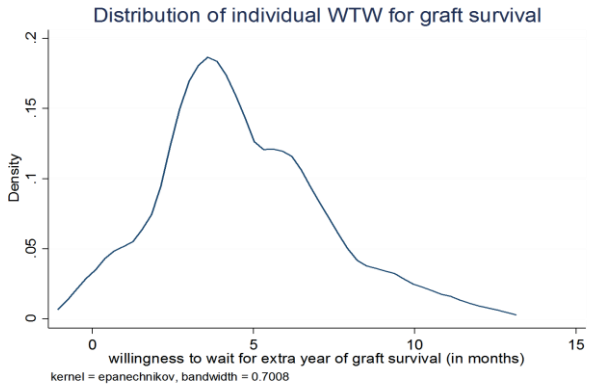
Table 13: Mixed Logit Model with Normally Distributed Coefficients and WTW Estimates

| | (1) Global M1 | (2) SD M1 | (3) WTW M1 | (4) Global M2 | (5) SD M2 | (6) WTW M2 |
|---|---|---|---|---|---|---|
| Waiting time | -0.083*** | | | -0.054*** | | |
| | (0.00398) | | | (0.003) | | |
| Graft survival | 0.389*** | 0.293*** | 4.720*** | 0.308*** | 0.292*** | 5.722*** |
| | (0.0339) | (0.0303) | (0.322) | (0.032) | (0.0268) | (0.469) |
| Standard infectious | 2.357*** | 1.421*** | 28.57*** | 1.542*** | 1.457*** | 28.61*** |
| | (0.147) | (0.108) | (1.358) | (0.127) | (0.105) | (2.055) |
| Standard neoplastic | 2.835*** | 1.799*** | 34.36*** | 1.598*** | 1.274*** | 29.66*** |
| | (0.180) | (0.163) | (1.787) | (0.133) | (0.123) | (2.090) |
| Cons | 0.138*** | | | 0.171*** | | |
| | (0.0487) | | | (0.0435) | | |
| Observations | 7,780 | 7,780 | 7,780 | 7,636 | | 7,636 |
| Candidates | 248 | | 248 | 248 | | 248 |
| Loglikelihood | -1946.207 | | | -2042.69 | | |

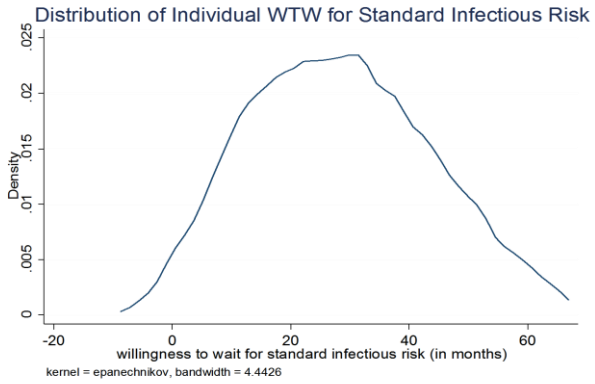
Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

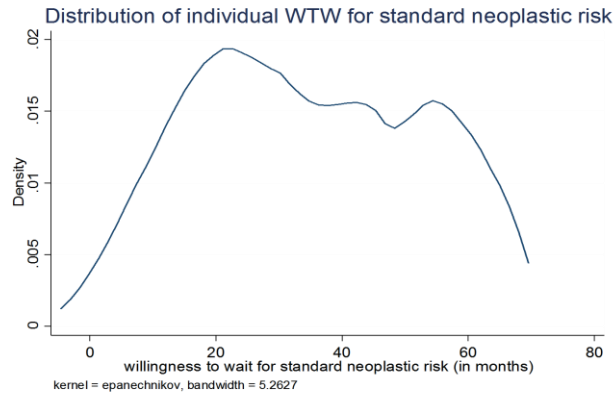
M1 is the mixed logit model for transplanted patients, and M2 is the mixed logit model for patients on waiting list (Genie, Nicolò, Pasini, 2017)




(a) WTW for extra year of survival




(b) WTW for standard infectious risk




(c) WTW for standard neoplastic risk

Figure18: Kernel plots of the distribution of individual WTW for the whole population

## 4. Further Analyses

Genie, Nicolò, Pasini found that recipients' preferences were driven by their age, and by the time they spent on dialysis. If the heterogeneity of tastes was driven only by recipients' characteristics, we would have found that all the respondents advise Antonio (the same in the entire questionnaire) to "do the same thing", regardless their own personal characteristics.
The evidence of heterogeneity, in the mixed logit results, shows us that preferences do not depend only on recipients attributes, but they vary across patients for unobserved reasons.

So far we excluded that the heterogeneity of preferences depends only on recipients' personal attributes, but we cannot exclude that it is, partially or fully, driven by transplanted respondents' characteristics.
For this reason, we continue our study through further analyses in order to understand if there is any covariate that drives differences in transplanted patients' willingness to wait. In order to do that, we broke down the analysis taking in account several different respondents' characteristics. The relevant results, obtained for differences in patients' age, both at the time of the questionnaire and at the time of transplantation, and for differences in patients' education, are reported and described in the following sections.

We broke down the analysis also for differences in other covariates, such as gender, whether respondents have at least one child, time passed from the transplantation date to the questionnaire filling, respondents' quality of life perception as transplanted patients, and patients' psychological status. None of these covariates gave statistically significant results in terms of difference in mean WTW between the analyzed groups. We reported summarizing tables with these regression results and the relative willingness to wait in Appendix A.

Table A.1 reports the estimation results and willingness to wait by gender. As anticipated, we observe that males and females show almost the same WTW for each attribute, this despite of fact that, in literature, there are several evidences of gender disparity in kidney transplantation. These differences concern mainly:
- chances to receive the organ: for instance, women are shown to have a lower chance of receiving kidney transplant than men[55];
- men's and women's preferences: women are less disposed than males to accept transplant surgery[56];

[55] Jindal, R., Ryan, et al. (2005).
[56] Legato MJ. (2004).

- different knowledge about transplantation diagnosis and therapy: women usually have less information about these processes[57];
- survival expectation: long-term retrospective studies in renal transplants revealed that male recipients undergo a worse survival in comparison to females[58].

Table A.2 reports estimation results and WTW differentiating respondents who have at least one child, from those with no child. Even here we found no statistically significant difference in the WTW, for any attribute, between the two groups. This result was quite predictable, indeed "whether a patient has children" is an attribute that in literature is usually significant when it concerns the future recipient of the kidney, because of the impact of the transplantation benefits on his/her family and dependents[59]. Here this variable does not concern the recipient (Antonio), but respondents' family composition, so there is no reason, and no support from the literature, to expect this covariate to give different results in patients' preferences.

Table A.3 shows the results for attribute coefficients and WTW by time from the transplantation. In Genie, Nicolò, Pasini's study there is evidence of different patients' preferences by time on dialysis, i.e. by how long it has passed since they started the dialysis therapy. Here we wanted to understand if there were similar results even for time from the transplantation, i.e. if patients who underwent a transplantation longer time ago have different preferences from those who have been transplanted more recently. As anticipated, there is no statistically significant evidence of an impact of this covariate on patients' preferences.

Table A.4 and A.5 summarize estimation results and WTW by respondent's quality of life perception as transplanted patient. The former is obtained by dividing the sample in two quantiles, the latter dividing it in three quantiles. Table A.6 reports results and WTW by psychological status directly for three quantiles. In literature we found examples that both these variables (quality of life perception[60] and psychological status[61]) have an impact on patients' preferences on medical treatments. Nevertheless, we found no evidence that these covariates affect transplanted patients' preferences in kidney allocation. In order to implement these two studies, we created two indexes based on the principal components analysis. We used answers to the question set 'B1'[62], in the questionnaire, for quality of life perception as

[57] Puoti, F et al. (2016).
[58] Chen, P. et al. (2013).
[59] Tong et al. (2012)
[60] Uhlmann, R. and Pearlman, R. (1991).
[61] Bowling, A. and Ebrahim, S. (2001).
[62] APPENDIX C

transplanted patients, and answers to question set 'B3'[58] for the analysis by psychological status. We reported the details of the indexes construction and all the general descriptions of the quantiles in Appendix B.

The fact that there is no evidence of an impact of psychological covariates on preferences is a very positive finding for our analysis. Indeed, whether the results had been driven by respondents' mood, our study would have strongly appeared weakened and less reliable.

On the other hand, it may be argued that these results can be biased by a self-selection problem in the sample. We notice that the majority of respondents provides a positive score on both their quality of life perception and psychological status. This evidence may suggest that only patients with a good psychological attitude took part in the experiment, while patients with depressed behavior did not answer to the questionnaire.

### 4.1 Estimation Results and WTW by Age at Questionnaire Date

We investigated also coefficients and WTW for attributes of kidney transplant according to respondents' age at the time in which they filled in the questionnaire.

This analysis will highlight whether respondents' age affects their intrinsic preferences about kidney attributes, regardless differences in recipient's age.

We split the sample in three quantiles defining three different groups: age 22-48, age 49-62 and 63-80.

Table 14 summarizes the results obtained with mixed logit models: we can notice that coefficients vary among different age-groups, but with a different trend from that obtained in the study about patients on dialysis. In the previous paper we saw evidence that younger patients would be willing to wait significantly longer, for better levels of the attributes, than recipients in the last quantiles.

From our model, conversely, we observe that the youngest group has a shorter willingness to wait for graft survival and neoplastic risk than the 49-62 age group. By the way, we should not to give too much importance to these results, which can be easily explained through literature about individual preferences. There are, indeed, many examples of a higher impatience of youngest subjects in comparison to middle age ones[63] [64] and it is also very plausible that the youngest patients found more difficult to put themselves in Antonio's shoes, mainly when it concerns health and medical issues.

There are, instead, no statistically significantly differences for any average WTW between 49-62 and 63-80 age groups, nor between 22-48 and 63-80 groups.

[63] Green, L., Fry, A.F. and Myerson, J. (1994).

[64] Scholar.Harvard.edu

If in the DCE with patients on waiting list for a transplantation, recipient's and respondent's roles coexisted, here it has been possible to separate them and to differentiate the results.

The evidence of no highly significant differences among age-groups for transplanted patients strengthens our hypothesis of heterogeneity due to individuals' intrinsic preferences, and that cannot be justified only by differences in respondents' ages.

Table 14: Estimation Results and WTW by Age at Questionnaire Time

| | (1) Mean Age22-48 | (2) WTW Age22-48 | (3) Mean Age49-62 | (4) WTW Age49-62 | (5) Mean Age63-80 | (6) WTW Age63-80 |
|---|---|---|---|---|---|---|
| Time | -0.0746*** | | -0.0815*** | | -0.0976*** | |
| | (0.00629) | | (0.00652) | | (0.00859) | |
| Graft survival | 0.286*** | 3.833*** | 0.4375*** | 5.369*** | 0.473*** | 4.843*** |
| | (0.0486) | (0.515) | (0.05933) | (0.574) | (0.0719) | (0.564) |
| Standard infectious risk | 2.228*** | 29.89*** | 2.2982*** | 28.20*** | 2.575*** | 26.37*** |
| | (0.250) | (2.661) | (0.2343) | (2.183) | (0.283) | (2.130) |
| Standard neoplastic risk | 2.189*** | 29.37*** | 3.0992*** | 38.03*** | 3.510*** | 35.95*** |
| | (0.255) | (2.734) | (0.3117) | (3.037) | (0.422) | (3.559) |
| Cons | 0.142* | | 0.103 | | 0.183* | |
| | (0.0809) | | (0.07978) | | (0.0965) | |
| **SD** | | | | | | |
| Survival | 0.194*** | | 0.330*** | | 0.357*** | |
| | (0.0456) | | (0.05025) | | (0.0681) | |
| Standard infectious | 1.518*** | | 1.380*** | | 1.472*** | |
| | (0.199) | | (0.1727) | | (0.207) | |
| Standard neoplastic | 1.354*** | | 1.7129*** | | 2.444*** | |
| | (0.228) | | (0.262) | | (0.408) | |
| Loglikelihood | -663.86557 | | -713.90462 | | -557.00329 | |
| Observations | 2,600 | 2,600 | 2,822 | 2,822 | 2,358 | 2,358 |

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

### 4.2 Estimation Results and WTW by Age at Transplantation Date

We computed then coefficients and WTW for attributes of kidney transplant by recipients' age, no more at the time of the questionnaire, but at the time in which they underwent the kidney transplantation. We are interested in understanding whether this covariate affects respondents' intrinsic preferences about kidney attributes, always regardless differences in

recipient's age. Table 15 summarizes these results. We divided the sample in three quantiles, the first one includes respondents who underwent the kidney transplantation between 19 and 42 years of age, the second one from 43 to 55 years of age, and the last one from 56 to 74. We notice that there is no statistically significant difference in WTW for any attributes among the groups, except for standard neoplastic risk for respondents in the second quantile. This group would be willing to wait, on average, over 42 months to obtain a kidney with this characteristic, which is significantly higher than the same WTW for both other groups at a 95% confidence level, and different only from the 19-42 age group, at 99% confidence level.

This only difference in WTW is too weak to confute our hypothesis of individual intrinsic preferences, and, for sure, cannot explain alone the high grade of heterogeneity found for all the attributes taken in consideration.

Table 15: Estimation Results and WTW by Age at Transplantation Time

| | (1) AgeTrans 19-42 | (2) WTW | (3) AgeTrans 43-55 | (4) WTW | (5) AgeTrans 56-74 | (6) WTW |
|---|---|---|---|---|---|---|
| Time | -0.0725*** | | -0.0816*** | | -0.0989*** | |
| | (0.00602) | | (0.00716) | | (0.00813) | |
| Graft survival | 0.302*** | 4.162*** | 0.421*** | 5.159*** | 0.482*** | 4.872*** |
| | (0.0514) | (0.564) | (0.0614) | (0.593) | (0.0685) | (0.526) |
| Standard infectious risk | 2.169*** | 29.91*** | 2.196*** | 26.91*** | 2.663*** | 26.92*** |
| | (0.240) | (2.677) | (0.251) | (2.355) | (0.268) | (1.965) |
| Standard neoplastic risk | 2.091*** | 28.83*** | 3.451*** | 42.30*** | 3.268*** | 33.04*** |
| | (0.251) | (2.811) | (0.337) | (3.232) | (0.387) | (3.175) |
| Cons | 0.133* | | 0.109 | | 0.169* | |
| | (0.0782) | | (0.0872) | | (0.0909) | |
| **SD** | | | | | | |
| Graft survival | 0.277*** | | 0.302*** | | 0.303*** | |
| | (0.0459) | | (0.0577) | | (0.0570) | |
| Standard infectious | 1.329*** | | 1.472*** | | 1.637*** | |
| | (0.170) | | (0.202) | | (0.217) | |
| Standard neoplastic | 1.560*** | | 1.921*** | | 1.965*** | |
| | (0.228) | | (0.294) | | (0.321) | |
| Loglikelihood | -713.97686 | | -588.95732 | | -615.85832 | |
| Observations | 2,740 | 2,740 | 2,408 | 2,408 | 2,568 | 2,568 |

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

### 4.3 Estimation Results and WTW by Education

Finally, we split the sample on the basis of respondents' education level. We defined three groups in order to identify possible variation in patients' WTW according to their education. The groups are: "Elementary", including respondents who attended only primary and/or secondary school, "High-School", for patients who achieved a high-school diploma, and "University", including respondents with at least a graduation degree.

From the literature we could expect the most educated individuals to have a lower time discount rate[65]. There are several evidences that these individuals are often more patient, and more willing to invest their time in order to obtain superior outcomes in the future[66] [67] [68] [69]. We could, hence, expect to observe higher WTW among these respondents, that would suggest Antonio to wait longer in order to be likely to receive a kidney with better levels of the attributes.

Table 16 summarizes the results obtained from this analysis. We notice that the expectations from literature are not supported by the evidences: respondents with the lowest level of education are those with the highest willingness to wait for Standard Infectious and Standard Neoplastic Risk attributes. The WTW for these attributes decrease when the respondents' education level rises. Between the "Elementary" group and the "College" group, the differences in WTW for both the risk attributes are statistically significant, so are the differences between WTW for Standard Infectious Risk between "Elementary" and "High-School", and between WTW for Standard Neoplastic Risk between "High-School" and "College".

A possible explanation to these results could be found assuming a correlation between respondents' education level and their profession, and a correlation between professions and respondents' WTW. We may assume, indeed, that the most educated patients are also those with more responsibilities at work, such as professionals or managers. These workers are usually difficult to substitute, hence they have a higher opportunity cost of waiting for the kidney transplantation. They may be, indeed, more impatient to be transplanted soon, in order to stop the dialysis treatments, which require quite long time, to resume quickly a normal and healthy life, and to maintain their economic status quo.

[65] We distinguish *time discounting* from *time preference*. We use the term *time discounting* broadly to encompass any reason for caring less about a future consequence, including factors that diminish the expected utility generated by a future consequence, such as uncertainty or changing tastes. [Frederick, et al. (2002).]

[66] Perez-Arce, F. (2011).

[67] Benjamin, D., Brown, S. and Shapiro, J. (2006).

[68] Bauer M., Chytilovà J. (2009.)

[69] Perez-Arce, F. (2011).

On the other hand, if the most educated respondents were actually the least patient ones, we should expect significant differences not only between WTW for risk attributes, but for all the attributes taken in consideration including Graft Survival, which appears not to vary between any of the three groups. Moreover, we found no support from the literature on the assumption of a correlation between profession and willingness to wait. Then, we are led to believe that there are other causes for these evidences.

Moreover we could assume a negative relation between education and risk aversion, i.e. less educated patients are more risk averse than those with higher study degrees. However, we know from the literature that the relation between these characteristics is unclear, and disentangling the different directions it may run is difficult. Many, indeed, are also the examples that schooling would increase the level of risk aversion[70].

The most reasonable explanation, on which also physicians and nephrologists of the Ospedale di Padova agree, is that these differences in WTW between groups depend on an overestimation of risk, both neoplastic and infectious, by less educated categories. Even though physicians explain and describe to patients the differences between "standard" and "augmented" risk levels of both the attributes, it seems likely that these information are absorbed differently by patients, depending on the education they received.
Nephrologists state that such high differences between WTW for standard infectious and standard neoplastic risks (respectively 35 and 43 months for the "Elementary" group versus 23 and 24 months for the "College" group) are not justified from a medical point of view. The risks categorized as "augmented", although higher than "standard" ones, are still very low.

- Augmented infectious risk: clinical studies reported in literature, and those conducted in Italy, state that infectious risk categorized as augmented, in kidneys ready to be transplanted, can be reduced at the minimum terms when proper precautions are taken. Indeed, an organ derived from a donor with an active infection is considered suitable to be transplanted only if the infection is not too extensive, and if the microorganism, which caused it, has been identified and can be treated with a specific antibiotic without additional risks.[71]
- Augmented neoplastic risk: a kidney, ready to be transplanted, is categorized with an augmented neoplastic risk if the donor has had a healed neoplasia in the last 10 years, or if the donor has an active neoplastic disease affecting other organs, but its transmission risk to the

[70] Jung S. (2015)
[71].Rete Nazionale trapianti. 2003. Modulo di consenso informato scritto: protocollo per l'utilizzo di Donatori affetti da meningite batterica, batteriemie o altre infezioni batteriche sistemiche.

recipient is much lower than the potential benefit that kidney transplantation would have for him/her[72]. Indeed a kidney with an augmented neoplastic risk is subjected to several in-depth medical analyses, and it is considered suitable to be transplanted only if no neoplasia has been found in the organ.

Table 16: Estimation Results and WTW by Education

| | (1) Mean Elementary | (2) WTW Elementary | (3) Mean High-school | (4) WTW High-school | (5) Mean College | (6) WTW College |
|---|---|---|---|---|---|---|
| Time | -0.0713*** | | -0.0830*** | | -0.106*** | |
| | (0.00625) | | (0.00597) | | (0.0105) | |
| Graft survival | 0.366*** | 5.126*** | 0.389*** | 4.683*** | 0.439*** | 4.132*** |
| | (0.0592) | (0.658) | (0.0493) | (0.468) | (0.0754) | (0.537) |
| Standard infectious risk | 2.476*** | 34.71*** | 2.245*** | 27.04*** | 2.399*** | 22.56*** |
| | (0.255) | (2.917) | (0.219) | (2.052) | (0.300) | (1.840) |
| Standard neoplastic risk | 3.054*** | 42.81*** | 2.892*** | 34.83*** | 2.548*** | 23.97*** |
| | (0.333) | (4.074) | (0.260) | (2.459) | (0.394) | (2.869) |
| Cons | 0.0420 | | 0.155** | | 0.273** | |
| | (0.0819) | | (0.0726) | | (0.114) | |
| **SD** | | | | | | |
| Graft survival | 0.328*** | | 0.280*** | | 0.258*** | |
| | (0.0519) | | (0.0413) | | (0.0677) | |
| Standard infectious | 1.590*** | | 1.525*** | | 1.007*** | |
| | (0.198) | | (0.177) | | (0.209) | |
| Standard neoplastic | 2.129*** | | 1.584*** | | 1.609*** | |
| | (0.292) | | (0.221) | | (0.323 | |
| Loglikelihood | -702.9452 | | -857.52164 | | -361.667 | |
| Observations | 2,898 | 2,898 | 3,416 | 3,416 | 1,466 | 1,466 |

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

The most important implication from these findings is that physicians need to improve the information about both infectious and neoplastic risks provided to the patients, with a particular attention for the least educated individuals. These subjects show some difficulties in assimilating these concepts, their characteristics and the actual differences between levels.

[72] Rete Nazionale trapianti. 2008. Modulo di consenso informato scritto: protocollo per l'utilizzo di Donatori a cui è stata diagnosticata una neoplasia in atto o pregressa.

A correct perception of risk by patients is a very important issue for physicians and health-economists. From the literature we know that personal health risk perceptions may be an important determinant of specific health-related behaviors[73], and it is central to provide the most complete education about these attributes to any category of patients, in order to train them appropriately and to put them in the position to consciously express their true preferences[74].

## 5. Conclusions

This study aims to highlight patients' time and risk preferences in kidney transplantation through a discrete choice experiment conducted with patients already transplanted, and compare the results with those obtained by Genie, Nicolò, Pasini, with patients on waiting list for the transplant.

Differently from this last study, in our DCE, respondents are not asked to choose treatments for themselves, but to advise a fictional patient, Antonio, with fixed personal characteristics. In this way we should be able to avoid problems arising when subjects are asked to choose for themselves, such as cognitive bias, and to highlight respondents' intrinsic preferences, setting recipient's characteristics as fixed.

As we could expect, these experimental studies show that both the categories of patients, transplanted and on waiting list, prefer a kidney transplant with shorter waiting time, longer expected graft survival, standard infectious risk, and standard neoplastic risk.

The mixed logit results suggest evidences of a substantial amount of preference heterogeneity for all the attributes considered, which has never been taken in account in the kidney allocation algorithm for transplantations.

We computed, then, WTW for the change in the levels of kidney transplant attributes, and we found that these ratios vary differently in the two studies. For patients on waiting list, willingness to wait differs according to age and time spent on dialysis. More specifically, younger candidates are willing to wait longer than older candidates for better quality kidney, such as patients who spent longer time on dialysis: the longer the time spent on dialysis, the longer WTW for better quality kidney in terms of an extra year of graft survival, standard infectious risk, and standard neoplastic risk.

[73] Janz, N., Becker, M. and Hartman, P. (1984).
[74] De Jonge, et al. (2009).

We show that also transplanted patients' WTW differ according to respondents' age (both at the time they filled in the questionnaire, both at the time they underwent the transplantation), but these relations are very weak and cannot explain the high grade of heterogeneity found by the mixed logit model.

Moreover, we found that WTW for infectious and neoplastic risk attributes differ according to respondents' education. Respondents with the lowest level of education are those with the highest willingness to wait for these attributes, and these WTW decrease when the respondents' education level rises. This last result suggest that less educated patients overestimate infectious and neoplastic risks in a manner that is not justified from a medical point of view. Presumably, this is due to some difficulties to these subjects in assimilating these concepts, their characteristics, and the actual differences between levels.

This finding is particularly significant, because it shows that the heterogeneity in transplanted patients' preferences is, partially, due to some problems in the way physicians and surgeons inform patients about the risk attributes considered in our study. This is a sign that these patients would need a more complete and accurate information about these attributes, in order to be able to consciously express their true preferences.

We can conclude that the majority of our analysis supports the hypothesis of heterogeneity of preferences due to individual intrinsic and unobservable tastes, such as patience or risk aversion. The kidney allocation algorithm for transplantation takes in account several medical and personal characteristics of candidates on waiting list, but it has never taken in account the differences in their preferences. This change would be important in order to improve the efficiency of the matching, and patients' satisfaction.

Nevertheless, we have seen that the preferences estimation is a very delicate process and it certainly requires a great attention to all the possible source of bias that could arise undertaking a discrete choice experiment.

First of all, we suggest adjusting and improving the information procedure about risk attributes and their levels, with a particular attention to less educated patients, in order to put them in the position to consciously express their true preferences.

# Appendix A

**Further Results**

Table A.1: Estimation Results and WTW by Gender

| | (1) Mean Female | (2) SD Female | (3) WTW Female | (4) Mean Male | (5) SD Male | (6) WTW Male |
|---|---|---|---|---|---|---|
| Time | -0.0858*** | | | -0.0823*** | | |
| | (0.00664) | | | (0.00514) | | |
| Survival | 0.367*** | 0.171*** | 4.277*** | 0.410*** | 0.373*** | 4.982*** |
| | (0.0469) | (0.0475) | (0.406) | (0.0483) | (0.0415) | (0.473) |
| Standard infectious risk | 2.411*** | 1.272*** | 28.11*** | 2.342*** | 1.623*** | 28.47*** |
| | (0.230) | (0.162) | (1.927) | (0.196) | (0.158) | (1.853) |
| Standard neoplastic risk | 2.931*** | 1.486*** | 34.17*** | 2.781*** | 1.951*** | 33.81*** |
| | (0.276) | (0.222) | (2.485) | (0.240) | (0.205) | (2.415) |
| Cons | 0.215*** | | | 0.105* | | |
| | (0.0793) | | | (0.0631) | | |
| Observations | 2,938 | 2,938 | 2,938 | 4,746 | 4,746 | 4,746 |
| Loglikelihood | -716.72035 | | | -1197.620 | | |

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table A.2: Estimation Results and WTW by Child

| | (1) Mean No Child | (2) SD No Child | (3) WTW No Child | (4) Mean With Child | (5) SD With Child | (6) WTW With Child |
|---|---|---|---|---|---|---|
| Time | -0.0770*** | | | -0.0871*** | | |
| | (0.00651) | | | (0.00513) | | |
| Survival | 0.358*** | 0.296*** | 4.648*** | 0.409*** | 0.302*** | 4.702*** |
| | (0.0567) | (0.0504) | (0.582) | (0.0429) | (0.0365) | (0.386) |
| Standard infectious risk | 2.396*** | 1.756*** | 31.10*** | 2.328*** | 1.315*** | 26.73*** |
| | (0.263) | (0.213) | (2.745) | (0.174) | (0.133) | (1.473) |
| Standard neoplastic risk | 2.827*** | 1.753*** | 36.69*** | 2.926*** | 1.843*** | 33.61*** |
| | (0.305) | (0.249) | (3.221) | (0.230) | (0.203) | (2.123) |
| Cons | 0.0968 | | | 0.165*** | | |
| | (0.0817) | | | (0.0613) | | |
| Loglikelihood | -693.1299 | | | -1245.8408 | | |
| Observations | 2,798 | 2,798 | 2,798 | 4,982 | 4,982 | 4,982 |

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table A.3: Estimation Results and WTW by Time from the Transplantation

| | (1) Mean 0-2 years | (3) WTW 0-2 years | (4) Mean 3-7 years | (6) WTW 3-7 years | (7) Mean 8-23 years | (9) WTW 8-23 years |
|---|---|---|---|---|---|---|
| Time | -0.0882*** | | -0.0799*** | | -0.0798*** | |
| | (0.00664) | | (0.00715) | | (0.00709) | |
| Graft survival | 0.410*** | 4.655*** | 0.352*** | 4.405*** | 0.396*** | 4.961*** |
| | (0.0533) | (0.472) | (0.0609) | (0.608) | (0.0629) | (0.615) |
| Standard infectious risk | 2.337*** | 26.51*** | 2.439*** | 30.52*** | 2.319*** | 29.05*** |
| | (0.226) | (1.877) | (0.266) | (2.541) | (0.276) | (2.732) |
| Standard neoplastic risk | 2.806*** | 31.83*** | 2.821*** | 35.29*** | 3.015*** | 37.76*** |
| | (0.278) | (2.448) | (0.332) | (3.446) | (0.352) | (3.661) |
| cons | 0.203*** | | 0.140 | | 0.0510 | |
| | (0.0780) | | (0.0897) | | (0.0878) | |
| Loglikelihood | -748.71345 | | -592.58048 | | -599.19906 | |
| Observations | 2,962 | 2,962 | 2,408 | 2,408 | 2,410 | 2,410 |

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table A.4: Estimation Results and WTW by Quality of Life Perception as Transplanted Patient (Two Quantiles)

| | (1) Mean Low | (2) SD Low | (3) WTW Low | (4) Mean High | (5) SD High | (6) WTW High |
|---|---|---|---|---|---|---|
| Time | -0.0728*** | | | -0.0933*** | | |
| | (0.00514) | | | (0.00637) | | |
| Graft survival | 0.332*** | 0.308*** | 4.562*** | 0.455*** | 0.296*** | 4.878*** |
| | (0.0473) | (0.0425) | (0.524) | (0.0511) | (0.0458) | (0.412) |
| Standard infectious risk | 2.119*** | 1.408*** | 29.10*** | 2.639*** | 1.545*** | 28.29*** |
| | (0.194) | (0.148) | (2.141) | (0.231) | (0.174) | (1.797) |
| Standard neoplastic risk | 2.510*** | 1.876*** | 34.46*** | 3.205*** | 1.634*** | 34.36*** |
| | (0.249) | (0.229) | (2.937) | (0.269) | (0.216) | (2.192) |
| Cons | 0.125* | | | 0.158** | | |
| | (0.0674) | | | (0.0721) | | |
| Loglikelihood | -1000.0909 | | | -913.29456 | | |
| Observations | 3,902 | 3,902 | 3,902 | 3,750 | 3,750 | 3,750 |

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table A.5: Estimation Results and WTW by Quality of Life Perception as Transplanted Patient (Three Quantiles)

| | (1) Mean Low | (2) WTW Low | (3) Mean Mid | (4) WTW Mid | (5) Mean High | (6) WTW High |
|---|---|---|---|---|---|---|
| Time | -0.076*** | | -0.0802*** | | -0.092*** | |
| | (0.00636) | | (0.00682) | | (0.0079) | |
| Survival | 0.339*** | 4.443*** | 0.377*** | 4.697*** | 0.453*** | 4.938*** |
| | (0.0545) | (0.568) | (0.0616) | (0.615) | (0.0626) | (0.515) |
| Standard infectious risk | 2.261*** | 29.68*** | 2.111*** | 26.32*** | 2.729*** | 29.78*** |
| | (0.240) | (2.487) | (0.255) | (2.472) | (0.286) | (2.174) |
| Standard neoplastic risk | 2.769*** | 36.34*** | 2.483*** | 30.97*** | 3.335*** | 36.40*** |
| | (0.314) | (3.504) | (0.298) | (2.994) | (0.335) | (2.756) |
| Cons | 0.143* | | 0.133 | | 0.142 | |
| | (0.0822) | | (0.0834) | | (0.0906) | |
| Loglikelihood | -689.9003 | | -641.98611 | | -580.22955 | |
| Observations | 2,778 | 2,778 | 2,456 | 2,456 | 2,418 | 2,418 |

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table A.6: Estimation Results and WTW by Psychological Status (Three Quantiles)

| | (1) Mean Low | (2) WTW Low | (3) Mean Mid | (4) WTW Mid | (5) Mean High | (6) WTW High |
|---|---|---|---|---|---|---|
| Time | -0.0791*** | | -0.0929*** | | -0.0838*** | |
| | (0.00662) | | (0.00736) | | (0.00781) | |
| Survival | 0.383*** | 4.847*** | 0.446*** | 4.797*** | 0.359*** | 4.280*** |
| | (0.0578) | (0.583) | (0.0564) | (0.452) | (0.0696) | (0.671) |
| Standard infectious risk | 2.165*** | 27.37*** | 2.665*** | 28.69*** | 2.465*** | 29.40*** |
| | (0.231) | (2.176) | (0.268) | (2.139) | (0.299) | (2.728) |
| Standard neoplastic risk | 2.813*** | 35.57*** | 3.210*** | 34.55*** | 2.617*** | 31.21*** |
| | (0.296) | (3.023) | (0.332) | (2.741) | (0.337) | (3.430) |
| Cons | 0.169** | | 0.140* | | 0.120 | |
| | (0.0826) | | (0.0840) | | (0.0942) | |
| Loglikelihood | -658.30603 | | -671.71322 | | -558.7945 | |
| Observations | 2,566 | 2,566 | 2,788 | 2,788 | 2,268 | 2,268 |

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

# Appendix B

## Construction of indexes for Quality of Life Perception and Psychological Status

### 1) Quality of Life Perception Index (QLPI)

**Question Set B1 in the Questionnaire**

In your opinion how true or false are the following sentences?

| | B1 | Absolutely true | Generally true | I do not know | Generally false | Absolutely false |
|---|---|---|---|---|---|---|
| a | The transplantation affected my life too much | 1 | 2 | 3 | 4 | 5 |
| b | The daily cares after the transplantation (therapies, medical check etc.) require too much time | 1 | 2 | 3 | 4 | 5 |
| c | Living as transplanted patient is frustrating | 1 | 2 | 3 | 4 | 5 |
| d | I feel like a burden to my family | 1 | 2 | 3 | 4 | 5 |

**Principal Components Analysis**

Table B.1: Principal Components Analysis for QLPI computed with Stata.14

| Variables | Component 1 | Component 2 | Component 3 | Component 4 | Unexplained |
|---|---|---|---|---|---|
| B1.a | 0.5451 | -0.3533 | -0.1391 | -0.7475 | 0 |
| B1.b | 0.4844 | -0.5895 | 0.2897 | 0.5779 | 0 |
| B1.c | 0.5112 | 0.3896 | -0.6969 | 0.3183 | 0 |
| B1.d | 0.4549 | 0.6132 | 0.6412 | -0.0773 | 0 |

**Index Construction and Characteristics**

$$QLPI = B1.a*(0.5451)^2+B1.b*(0.4844)^2+B1.c*(0.5112)^2+B1.d*(0.4549)^2$$

with B1.a, B1.b, B1.c, B1.d equals to the number [1-5] expressed by each patient in the corresponding section of question set B1.

The index can vary from a minimum of 1 (for respondents with a bad quality of life perception) to a maximum of 5 (when respondents assign the highest score of satisfaction, 5, to all the section of question set B1).

**Description of the Sample**

| **Two Quantiles** | Observations | Mean | Std. Dev. | Min | Max |
|---|---|---|---|---|---|
| Below the mean | 3,902 | 3.897 | 0.629 | 1,766 | 4.496 |
| Above the mean | 3,750 | 4.895 | 0.147 | 4.504 | 5.000 |

| **Three Quantiles** | Observations | Mean | Std. Dev. | Min | Max |
|---|---|---|---|---|---|
| 1st Quantile | 2,778 | 3.667 | 0.610 | 1.766 | 4.261 |
| 2nd Quantile | 2,456 | 4.597 | 0.135 | 4.793 | 4.766 |
| 3rd Quantile | 2,418 | 4.997 | 0.024 | 4.793 | 5.000 |

## 2) Psychological Status Index (PSI)

### Question Set B3 in the Questionnaire

How often, in the last 4 weeks, have you felt…

| B3 | Always | Almost always | Usually | Sometimes | Almost never | Never |
|---|---|---|---|---|---|---|
| a calm and quiet? | 1 | 2 | 3 | 4 | 5 | 6 |
| b full of energies? | 1 | 2 | 3 | 4 | 5 | 6 |
| c downhearted and sad? | 1 | 2 | 3 | 4 | 5 | 6 |

### Principal Components Analysis

Table B.2: Principal Components Analysis for PSI computed with Stata.14

| Variables | Component 1 | Component 2 | Component 3 | Unexplained |
|---|---|---|---|---|
| B3.a | 0.6064 | -0.282 | 0.7435 | 0 |
| B3.b | 0.5322 | 0.8386 | -0.1160 | 0 |
| B3.c | -0.5908 | 0.4661 | 0.6586 | 0 |

### Index Construction and Characteristics

$$PSI = B3.a*(0.6064)^2+B3.b*(0.5322)^2 - B3.c*(-0.5908)^2$$

with *B3.a*, *B3.b*, *B3.c* equals to the number [1-6] expressed by each patient in the corresponding section of question set B3.

Differently from the previous index, here we have to notice that the scores related to answers for sections (a) and (b) have different trends from that of section (c): if in the former case the lowest score, equal to 1, corresponds to the best psychological status, in questions (c) this one corresponds to the worst mood.

In order to face this problematic we set a negative sign for the component *B3.c* in the formula. For the reasons seen above we can conclude that the index can vary from a minimum of -1.443 (for respondents with the most positive psychological status) to a maximum of 3.996 (for respondents with the bluest mood).

### Description of the Sample

| | Observations | Mean | Std. Dev. | Min | Max |
|---|---|---|---|---|---|
| 1st Quantile | 2,566 | -0.707 | 0.264 | -1.443 | -0.424 |
| 2nd Quantile | 2,788 | 0.089 | 0.246 | -0.359 | 0.491 |
| 3rd Quantile | 2,268 | 1.208 | 0.543 | 0.509 | 3.189 |

# Appendix C

**Original Questionnaire as administrated to transplanted patients**

## QUESTIONARIO

Buongiorno,
Faccio parte di un gruppo di ricercatori dell'Università di Padova e dell'Università Ca' Foscari di Venezia, che sta svolgendo uno studio che ha lo scopo di valutare se sia possibile aumentare il benessere dei pazienti che necessitano di un trapianto di rene.
Lei è già stato intervistato nell'abito di questo progetto di ricerca, stiamo ora intervistando nuovamente tutti i pazienti del centro trapianti di rene e pancreas di Padova.
La Sua partecipazione a questa indagine è di estrema importanza ai fini della ricerca scientifica. Le chiederemo alcune informazioni demografiche, alcune informazioni relative al Suo stato di salute generale e infine le chiederemo di esprimere la Sua preferenza circa opzioni alternative di trattamenti medici.
I risultati di questo studio verranno pubblicati in riviste scientifiche specializzate e presentati in conferenze scientifiche, ma nessuna pubblicazione o presentazione conterrà mai il Suo nome né alcuna informazione che potrebbe identificarLa. Le preferenze da Lei espresse in questo questionario non avranno alcuna implicazione sulla allocazione degli organi nel Suo o in nessun altro caso, e non verranno incluse nella Sua cartella clinica.
Tutti i dati raccolti saranno archiviati e analizzati in maniera rigorosamente anonima, ai sensi dell'art. 7 e dell'art. 13 del DLgs n. 196/03 in vigore dal 1° gennaio 2004 sulla tutela delle persone rispetto al trattamento dei dati personali. È inoltre severamente vietato l'uso dei suoi dati a fini commerciali.
Se non ha domande o richieste di chiarimenti ulteriori, possiamo iniziare l'intervista.

**Dati Socio-anagrafici**

D2) Come è composta la sua famiglia (non solo le persone che vivono con lei)?
□madre
□padre
□fratelli/sorelle □ M - n°___ _____ □ F - n°_____
□moglie
□marito
□convivente
□figli □ M - n°_____ □ F - n°_____
□altro _____

D3) Qual è attualmente la sua professione?

| | | |
|---|---|---|
| □dirigente | □libero professionista | □impiegato |
| □operaio | □casalinga | □pensionato |
| □studente | □altro_____ | |

D4) Attualmente gode di una pensione di invalidità ?
□ Sì □ No

**Benessere psicologico e qualità della vita**

B1) Secondo lei quanto vere o quanto false sono le seguenti affermazioni?

| | | **assolutamente vera** | **in genere vera** | **non so** | **in genere falsa** | **assolutamente falsa** |
|---|---|---|---|---|---|---|
| a | La vita da trapiantato mi condiziona troppo | 1 | 2 | 3 | 4 | 5 |
| b | La gestione quotidiana del trapianto (terapie, controlli ecc.) mi fa perdere troppo tempo | 1 | 2 | 3 | 4 | 5 |
| c | Trovo frustrante vivere da trapiantato | 1 | 2 | 3 | 4 | 5 |
| d | Mi sento un peso per la mia famiglia | 1 | 2 | 3 | 4 | 5 |

B2) In generale direbbe che la sua salute è?

| | **Ottima** | **Molto buona** | **Buona** | **Discreta** | **Scadente** |
|---|---|---|---|---|---|
| A | 1 | 2 | 3 | 4 | 5 |

B3) Per quanto tempo nelle ultime 4 settimane si è sentito…

| | | **Sempre** | **Quasi sempre** | **Molto tempo** | **Una parte del tempo** | **Quasi mai** | **Mai** |
|---|---|---|---|---|---|---|---|
| a | Calmo e sereno? | 1 | 2 | 3 | 4 | 5 | 6 |
| b | Pieno di energie? | 1 | 2 | 3 | 4 | 5 | 6 |
| c | Scoraggiato e triste? | 1 | 2 | 3 | 4 | 5 | 6 |

**Preferenze dei pazienti**

In questa sezione le saranno presentate sedici opzioni alternative di trattamenti. La sarà chiesto di esprimere la sua preferenza tra il trattamento A e il trattamento B ponendo una X nel riquadro sotto di esse. Le ricordiamo di nuovo che le risposte non avranno alcuna influenza sulle terapie che le verranno proposte.

- la sopravvivenza dell'organo trapiantato è determinata dalle caratteristiche dell'organo stesso, dalle caratteristiche del ricevente e dalla compatibilità tra donatore e ricevente. Queste caratteristiche permettono di stimare per quanto tempo l'organo trapiantato sarà funzionante. Tale valutazione è il risultato di un calcolo probabilistico basato su dati clinici precedenti e sull'esperienza del medico che esegue la valutazione, ma come tale è soggetta ad un certo grado di incertezza.

- il rischio infettivo (standard o aumentato) è il rischio di contrarre una malattia infettiva attraverso l'organo trapiantato. Se è standard, l'organo trapiantato è stato sottoposto a tutti i controlli necessari, anche se non è possibile escludere del tutto tale rischio. Se il rischio è aumentato, l'organo trapiantato è stato sottoposto a tutti i controlli necessari, ma il donatore aveva tenuto dei comportamenti a rischio nei giorni precedenti al suo decesso ed un'eventuale infezione potrebbe non essere rilevabile anche dai più accurati controlli;

- il rischio neoplastico (standard o aumentato) è il rischio di contrarre una neoplasia attraverso l'organo trapiantato. Se è standard, il donatore non era affetto da neoplasie rilevabili clinicamente, anche se non è possibile escludere del tutto tale rischio. È aumentato nel caso il donatore sia stato affetto in passato da patologie neoplastiche che sono state curate e considerate guarite o da neoplasie senza potenziale di diffusione ad altri organi. Il rischio di trasmissione dal donatore al ricevente è comunque minimo.

- il tempo d'attesa è il numero di mesi che si dovranno aspettare per ottenere il trapianto proposto. Il tempo d'attesa dipende dalle caratteristiche del ricevente e dalla frequenza con cui sono solitamente disponibili donatori di una certa tipologia. Queste caratteristiche permettono di valutare approssimativamente il tempo d'attesa, anche se c'è sempre una qualche probabilità che l'attesa sia inferiore o superiore a quanto dichiarato.

Antonio è un paziente in attesa di trapianto di rene. Antonio ha 45 anni, è in dialisi da due anni e mezzo, è in attesa di un trapianto di rene da un anno e mezzo, è sposato ed ha due figli. Antonio ha un titolo di scuola superiore ed è impiegato. A parte i problemi ai reni, Antonio gode di buona salute.

Antonio deve esprimere la propria preferenza riguardo 16 coppie di trattamenti che gli vengono prospettati, e chiede il suo consiglio.
Riporti il suo consiglio ad Antonio riguardo ogni coppia di trattamenti A e B ponendo una X nel riquadro sotto di esse.

T1

| **Trattamento A** | **Trattamento B** |
|---|---|
| Elevata probabilità che l'organo trapiantato sia funzionante per: 20 anni | Elevata probabilità che l'organo trapiantato sia funzionante per: 15 anni |
| Rischio infettivo: Standard | Rischio infettivo: Standard |
| Rischio neoplastico: Aumentato | Rischio neoplastico: Standard |
| Elevata probabilità di attendere in lista per: 6 mesi | Elevata probabilità di attendere in lista per: 6 mesi |
| ☐ | ☐ |

T2

| **Trattamento A** | **Trattamento B** |
|---|---|
| Elevata probabilità che l'organo trapiantato sia funzionante per: 15 anni | Elevata probabilità che l'organo trapiantato sia funzionante per: 20 anni |
| Rischio infettivo: Standard | Rischio infettivo: Aumentato |
| Rischio neoplastico: Standard | Rischio neoplastico: Aumentato |
| Elevata probabilità di attendere in lista per: 12 mesi | Elevata probabilità di attendere in lista per: 36 mesi |
| ☐ | ☐ |

T3

| **Trattamento A** | **Trattamento B** |
|---|---|
| Elevata probabilità che l'organo trapiantato sia funzionante per: 20 anni | Elevata probabilità che l'organo trapiantato sia funzionante per: 15 anni |
| Rischio infettivo: Standard | Rischio infettivo: Aumentato |
| Rischio neoplastico: Aumentato | Rischio neoplastico: Standard |
| Elevata probabilità di attendere in lista per: 60 mesi | Elevata probabilità di attendere in lista per: 6 mesi |
| ☐ | ☐ |

T4

| **Trattamento A** | **Trattamento B** |
|---|---|
| Elevata probabilità che l'organo trapiantato sia funzionante per: 10 anni | Elevata probabilità che l'organo trapiantato sia funzionante per: 10 anni |
| Rischio infettivo: Aumentato | Rischio infettivo: Standard |
| Rischio neoplastico: Aumentato | Rischio neoplastico: Aumentato |
| Elevata probabilità di attendere in lista per: 6 mesi | Elevata probabilità di attendere in lista per: 12 mesi |
| ☐ | ☐ |

T5

| **Trattamento A** | **Trattamento B** |
|---|---|
| Elevata probabilità che l'organo trapiantato sia funzionante per: 10 anni | Elevata probabilità che l'organo trapiantato sia funzionante per: 10 anni |
| Rischio infettivo: Aumentato | Rischio infettivo: Standard |
| Rischio neoplastico: Standard | Rischio neoplastico: Standard |
| Elevata probabilità di attendere in lista per: 36 mesi | Elevata probabilità di attendere in lista per: 60 mesi |
| ☐ | ☐ |

T6

| **Trattamento A** | **Trattamento B** |
|---|---|
| Elevata probabilità che l'organo trapiantato sia funzionante per: 15 anni | Elevata probabilità che l'organo trapiantato sia funzionante per: 10 anni |
| Rischio infettivo: Aumentato | Rischio infettivo: Aumentato |
| Rischio neoplastico: Aumentato | Rischio neoplastico: Standard |
| Elevata probabilità di attendere in lista per: 60 mesi | Elevata probabilità di attendere in lista per: 36 mesi |
| ☐ | ☐ |

T7

| **Trattamento A** | **Trattamento B** |
|---|---|
| Elevata probabilità che l'organo trapiantato sia funzionante per: 20 anni | Elevata probabilità che l'organo trapiantato sia funzionante per: 20 anni |
| Rischio infettivo: Aumentato | Rischio infettivo: Standard |
| Rischio neoplastico: Standard | Rischio neoplastico: Aumentato |
| Elevata probabilità di attendere in lista per: 60 mesi | Elevata probabilità di attendere in lista per: 60 mesi |
| ☐ | ☐ |

T8

| **Trattamento A** | **Trattamento B** |
|---|---|
| Elevata probabilità che l'organo trapiantato sia funzionante per: 15 anni | Elevata probabilità che l'organo trapiantato sia funzionante per: 10 anni |
| Rischio infettivo: Standard | Rischio infettivo: Aumentato |
| Rischio neoplastico: Aumentato | Rischio neoplastico: Aumentato |
| Elevata probabilità di attendere in lista per: 36 mesi | Elevata probabilità di attendere in lista per: 6 mesi |
| ☐ | ☐ |

T9

| **Trattamento A** | **Trattamento B** |
|---|---|
| Elevata probabilità che l'organo trapiantato sia funzionante per: 15 anni | Elevata probabilità che l'organo trapiantato sia funzionante per: 20 anni |
| Rischio infettivo: Standard | Rischio infettivo: Aumentato |
| Rischio neoplastico: Standard | Rischio neoplastico: Standard |
| Elevata probabilità di attendere in lista per: 6 mesi | Elevata probabilità di attendere in lista per: 12 mesi |
| ☐ | ☐ |

T10

| **Trattamento A** | **Trattamento B** |
|---|---|
| Elevata probabilità che l'organo trapiantato sia funzionante per: 10 anni | Elevata probabilità che l'organo trapiantato sia funzionante per: 15 anni |
| Rischio infettivo: Standard | Rischio infettivo: Aumentato |
| Rischio neoplastico: Aumentato | Rischio neoplastico: Aumentato |
| Elevata probabilità di attendere in lista per: 12 mesi | Elevata probabilità di attendere in lista per: 60 mesi |
| ☐ | ☐ |

T11

| **Trattamento A** | **Trattamento B** |
|---|---|
| Elevata probabilità che l'organo trapiantato sia funzionante per: 20 anni | Elevata probabilità che l'organo trapiantato sia funzionante per: 20 anni |
| Rischio infettivo: Aumentato | Rischio infettivo: Standard |
| Rischio neoplastico: Standard | Rischio neoplastico: Standard |
| Elevata probabilità di attendere in lista per: 12 mesi | Elevata probabilità di attendere in lista per: 36 mesi |

☐ ☐

T12

| **Trattamento A** | **Trattamento B** |
|---|---|
| Elevata probabilità che l'organo trapiantato sia funzionante per: 15 anni | Elevata probabilità che l'organo trapiantato sia funzionante per: 15 anni |
| Rischio infettivo: Aumentato | Rischio infettivo: Standard |
| Rischio neoplastico: Standard | Rischio neoplastico: Standard |
| Elevata probabilità di attendere in lista per: 6 mesi | Elevata probabilità di attendere in lista per: 12 mesi |

☐ ☐

T13

| **Trattamento A** | **Trattamento B** |
|---|---|
| Elevata probabilità che l'organo trapiantato sia funzionante per: 10 anni | Elevata probabilità che l'organo trapiantato sia funzionante per: 15 anni |
| Rischio infettivo: Standard | Rischio infettivo: Aumentato |
| Rischio neoplastico: Standard | Rischio neoplastico: Aumentato |
| Elevata probabilità di attendere in lista per: 60 mesi | Elevata probabilità di attendere in lista per: 12 mesi |

☐ ☐

T14

| **Trattamento A** | **Trattamento B** |
|---|---|
| Elevata probabilità che l'organo trapiantato sia funzionante per: 20 anni | Elevata probabilità che l'organo trapiantato sia funzionante per: 20 anni |
| Rischio infettivo: Aumentato | Rischio infettivo: Aumentato |
| Rischio neoplastico: Aumentato | Rischio neoplastico: Standard |
| Elevata probabilità di attendere in lista per: 36 mesi | Elevata probabilità di attendere in lista per: 60 mesi |

☐ ☐

T15

| **Trattamento A** | **Trattamento B** |
|---|---|
| Elevata probabilità che l'organo trapiantato sia funzionante per: 20 anni | Elevata probabilità che l'organo trapiantato sia funzionante per: 20 anni |
| Rischio infettivo: Standard | Rischio infettivo: Standard |
| Rischio neoplastico: Standard | Rischio neoplastico: Aumentato |
| Elevata probabilità di attendere in lista per: 36 mesi | Elevata probabilità di attendere in lista per: 6 mesi |

☐ ☐

T16

| **Trattamento A** | **Trattamento B** |
|---|---|
| Elevata probabilità che l'organo trapiantato sia funzionante per: 15 anni | Elevata probabilità che l'organo trapiantato sia funzionante per: 15 anni |
| Rischio infettivo: Aumentato | Rischio infettivo: Standard |
| Rischio neoplastico: Aumentato | Rischio neoplastico: Aumentato |
| Elevata probabilità di attendere in lista per: 12 mesi | Elevata probabilità di attendere in lista per: 36 mesi |
| ☐ | ☐ |

**Abilità logiche**

Ora vorrei farle alcune domande che servono per valutare come le persone usino i numeri nella vita di tutti i giorni.

A1) La probabilità di contrarre una malattia è pari al 10 percento. Su 1000 persone, quante ci si può aspettare che si ammalino?

…….

A2) Durante i saldi, un negozio vende tutto a metà prezzo. Prima dei saldi, un divano costava 300 euro; quanto costerà lo stesso divano durante i saldi?

…….

A3) Un rivenditore di auto usate vende un'auto a 6.000 Euro, pari ai due terzi (2/3) del costo della stessa auto nuova. Quanto costava l'auto nuova?

…….

Il questionario è terminato. La ringraziamo per la sua preziosa collaborazione.

Le ricordo che questo questionario ha soli scopi scientifici e non ha alcuna rilevanza per quanto riguarda il tipo di terapia che le verrà proposta o le scelte future che eventualmente Lei sarà chiamato a fare in accordo con la équipe di medici che La segue.

# References


Lancaster, K. (1966). A New Approach to Consumer Theory. *Journal of Political Economy*, 74(2), pp.132-157.

McFadden D. (1974). Conditional logit analysis of qualitative choice behavior. In: Zarembka P, editor. Frontiers of econometrics. *New York: Academic Press*, 105-42.

Hanemann, W. (1984). Discrete/Continuous Models of Consumer Demand. *Econometrica*, 52(3), p.541.

Lancsar, E. and Louviere, J. (2008). Conducting Discrete Choice Experiments to Inform Healthcare Decision Making. *PharmacoEconomics*, 26(8), pp.661-677.

Loyd A. (2001). The extent of patients' understanding of the risk of treatments. *Q Health Care*, 10 (Suppl I):i14-18.

Huber, J. and Zwerina, K. (1996). The Importance of Utility Balance in Efficient Choice Designs. *Journal of Marketing Research*, 33(3), p.307.

Street D.J. and Burgess L. (2008). The Construction of Optimal Stated Choice Experiments: Theory and Methods. *Biometrics*, 64(3), pp.997-998.

Viney, R., Savage, E. and Louviere, J. (2005). Empirical investigation of experimental design properties of discrete choice experiments in health care. *Health Economics*, 14(4), pp.349-362.

En.wikipedia.org. (2017). Pilot experiment. [online] Available at: https://en.wikipedia.org/wiki/Pilot_experiment [Accessed 11 Oct. 2017].

Bech, M. and Gyrd-Hansen, D. (2005). Effects coding in discrete choice experiments. *Health Economics*, 14(10), pp.1079-1083.

En.wikipedia.org. (2017). *Random effects model*. [online] Available at: https://en.wikipedia.org/wiki/Random_effects_model [Accessed 11 Nov. 2017]..

Train, K. (2009). *Discrete choice methods with simulation*. Cambridge University Press, pp.134-150.

McFadden, D. and Train, K. (2000). Mixed MNL models for discrete response. *Journal of Applied Econometrics*, 15(5), pp.447-470.

Train K, Sonnier G. Mixed logit with bounded distributions of partworths. Working paper, University of California, Department of Economics.

Louviere J, Eagle T. (2006). Confound it! That persky little scale constant messes up our convenient assumptions. *CenSoCWorking* Paper No. 06-002, University of Technology Sydney.

American Educational Research Association, American Psychological Association, & National Council on Measurement in Education. (1999) Standards for educational and psychological testing. Washington, DC: American Educational Research Association.

Heukelom F. (2009). Origin and Interpretation of Internal and External Validity in Economics. *NiCE*. Working Paper 09-111

Lancsar, E. and Louviere, J. (2006). Deleting 'irrational' responses from discrete choice experiments: a case of investigating or imposing preferences?. *Health Economics*, 15(8), pp.797-811.

De Palma , Myers G, papageorgious Y. (1994). Rational choice under an imperfect ability to choose. *American Economics Review*, 11:117-27

Scott A. (2002). Identifying and analyzing dominant preferences in discrete choice experiments. *J Econ Psychol*, 23:383-98

Leave, C., Payne, J., Bettman, J. and Johnson, E. (1994). The Adaptive Decision Maker. *The Journal of the Operational Research Society*, 45(7), pp.34-6.

Lancsar E, Louviere J, Flynn T. (2007). Several methods to investigate relative attribute impact in stated preference experiments. Soc.Sci Med; 64: 1738-53

Louviere, J. and Woodworth, G. (1983). Design and Analysis of Simulated Consumer Choice or Allocation Experiments: An Approach Based on Aggregate Data. *Journal of Marketing Research*, 20(4), p.350.

Propper, C. (1990). Contingent Valuation of Time Spent on NHS Waiting Lists. *The Economic Journal*, 100(400), p.193.

Jonsson, M. and Alban, A. (1988). Methods for the Economic Evaluation of Health Care Programmes, M. F. Drummond, G. L. Stoddard, and G. W. Torrance. Oxford: Oxford University Press, 1987, 182 pp. *International Journal of Technology Assessment in Health Care*, 4(04), pp.643-644.

Clark, M., Determann, D., Petrou, S., Moro, D. and de Bekker-Grob, E. (2014). Discrete Choice Experiments in Health Economics: A Review of the Literature. *PharmacoEconomics*, 32(9), pp.883-902.

Hol, L., de Bekker-Grob, E., van Dam, L., Donkers, B., Kuipers, E., Habbema, J., Steyerberg, E., van Leerdam, M. and Essink-Bot, M. (2010). Preferences for colorectal cancer screening strategies: a discrete choice experiment. British *Journal of Cancer*, 102(6), pp.972-980.

Marti J. (2012). Assessing preferences for improved smoking cessation medications: a discrete choice experiment. *Eur J Health* Econ.;13(5):533–48.

Regier, D., Diorio, C., Ethier, M., Alli, A., Alexander, S., Boydell, K., Gassas, A., Taylor, J., Kellow, C., Mills, D. and Sung, L. (2012). Discrete Choice Experiment to Evaluate Factors That Influence Preferences for Antibiotic Prophylaxis in Pediatric Oncology. *PLoS ONE*, 7(10), p.e47470.

Johnson, F., Ozdemir, S. and Phillips, K. (2010). Effects of simplifying choice tasks on estimates of taste heterogeneity in stated-choice surveys. *Social Science & Medicine*, 70(2), pp.183-190.

Ryan, M., Yi, D., Avenell, A., Douglas, F., Aucott, L., van Teijlingen, E. and Vale, L. (2014). Gaining pounds by losing pounds: preferences for lifestyle interventions to reduce obesity. *Health Economics, Policy and Law*, 10(02), pp.161-182.

World Health Organization. (2017). *Obesity and overweight*. [online] Available at: http://www.who.int/mediacentre/factsheets/fs311/en/ [Accessed Oct. 2017].

Nhs.uk. (2017). *Britain: 'the fat man of Europe' - Live Well - NHS Choices*. [online] Available at: http://www.nhs.uk/Livewell/loseweight/Pages/statistics-and-causes-of-the-obesity-epidemic-in-the-UK.aspx [Accessed Oct. 2017].

Kjær, T. and Gyrd-Hansen, D. (2008). Preference heterogeneity and choice of cardiac rehabilitation program: Results from a discrete choice experiment. *Health Policy*, 85(1), pp.124-132.

Bryan, S. and Dolan, P. (2004). Discrete choice experiments in health economics. *The European Journal of Health Economics, formerly: HEPAC*, 5(3), pp.199-202.

Lancsar, E. and Donaldson, C. (2005). Discrete choice experiments in health economics. *The European Journal of Health Economics*, 6(4), pp.314-316..

Genie M., Nicolò A., Pasini G. (2017). Eliciting Patients' Preferences in Kidney Transplantation: A Discrete Choice Experiment

Trapianti.salute.gov.it. (2017). *Trapianti - Trapianto*. [online] Available at: http://www.trapianti.salute.gov.it/cnt/cntDettaglioMenu.jsp?id=71&area=cnt-organi&menu=menuPrincipale&sotmenu=trapianto&label=mot&livello=1 [Accessed 21 Oct. 2017].

Trapianti.salute.gov.it. (2017). Trapianti - Liste di attesa. [online] Available at: http://www.trapianti.salute.gov.it/cnt/cntDettaglioMenu.jsp?id=125&area=cnt-organi&menu=menuPrincipale&sotmenu=trapianto&label=mo [Accessed 21 Oct. 2017].t

Trapianti.salute.gov.it. (2017). *Trapianti - Trapianto*. [online] Available at: http://www.trapianti.salute.gov.it/cnt/cntDettaglioMenu.jsp?id=71&area=cnt-organi&menu=menuPrincipale&sotmenu=trapianto&label=mot&livello=1 [Accessed 21 Oct. 2017].

Linee guida per la gestione delle liste di attesa e la assegnazione dei trapianto di rene da donatore cadavere. (n.d.). [pdf] Centro Nazionale Trapianti. Available at: http://www.trapianti.salute.gov.it/imgs/C_17_normativa_13_allegato.pdf [Accessed 21 Oct. 2017].

Il mattino di Padova (2008/02/28). Come funzionano le liste d'attesa.

Il Secolo d'Italia (2017/02/22). Trapianto di rene: Padova leader in Italia, superati i 2000 interventi.

Ministero della Salute (2016). *6 Criteri di allogazione rene NITp*.?..

Valutazione di qualità dell'attività del trapianto di Rene 2000-2014. (2016). [ebook] rete Nazionale Trapianti. Available at: http://www.trapianti.salute.gov.it/imgs/C_17_pubblicazioni_2595_ulteriorieallegati_ulteriore allegato_1_alleg.pdf [Accessed Oct. 2017].

Il fatto quotidiano. (2017/01/10). Trapianti e donazioni di organi: 2016 da record in Italia. 3736 pazienti operati

Il mattino Padova. (2017/02/22). Padova: superati i duemila trapianti di rene.

Jindal, R., Ryan, J., Sajjad, I., Murthy, M. and Baines, L. (2005). Kidney Transplantation and Gender Disparity. *American Journal of Nephrology*, 25(5), pp.474-483.

Legato MJ. Gender-specific issues in organ transplantation. In: Sanfey IH, FrcsiFrcsi F, editors. (2004). Principles of gender-specific medicine. 1. New York: Academic; pp. 1116–27.

Puoti, F., Ricci, A., Nanni-Costa, A., Ricciardi, W., Malorni, W. and Ortona, E. (2016). Organ transplantation and gender differences: a paradigmatic example of intertwining between biological and sociocultural determinants. *Biology of Sex Differences*, 7(1).

Chen, P., Tsai, M., Lee, C., Yang, C., Hu, R., Lee, P. and Lai, H. (2013). Gender differences in renal transplant graft survival. *Journal of the Formosan Medical Association*, 112(12), pp.783-788.

Tong, A., Jan, S., Wong, G., Craig, J., Irving, M., Chadban, S., Cass, A., Marren, N. and Howard, K. (2012). Patient Preferences for the Allocation of Deceased Donor Kidneys for Transplantation: A Mixed Methods Study. *Transplantation Journal*, 94(10S), p.342.

Uhlmann, R. and Pearlman, R. (1991). Perceived quality of life and preferences for life-sustaining treatment in older adults. *Archives of Internal Medicine*, 151(3), pp.495-497.

Bowling, A. and Ebrahim, S. (2001). Measuring patients' preferences for treatment and perceptions of risk. *Quality and Safety in Health Care*, 10(Supplement 1), pp.i2-i8.

Green, L., Fry, A.F. and Myerson, J. (1994). Discounting of delayed rewards: a life-span comparison. *Psychological Science5*, 33–7

Intertemporal choice. (n.d.). [pdf] Available at: https://scholar.harvard.edu/files/laibson/files/intertemporal_choice.pdf [Accessed Nov. 2017].

Frederick, S., Loewenstein, G. and O'donoghue, T. (2002). Time Discounting and Time Preference: A Critical Review. *Journal of Economic Literature*, 40(2), pp.351-401.

Perez-Arce, F. (2011). The Effect of Education on Time Preferences. *SSRN Electronic Journal*.

Benjamin, D., Brown, S. and Shapiro, J. (2006). Who is 'Behavioral'? Cognitive Ability and Anomalous Preferences.*SSRN Electronic Journal*.

Bauer M., Chytilovà J. (2009). Time Discounting, Education, and Growth: Evidence and a Simple Model. *Czech Journal of Economics and Finance*, 1, pp.71-86.

Perez-Arce, F. (2011). The Effect of Education on Time Preferences. *SSRN Electronic Journal*.

Rete Nazionale trapianti. (2003). Modulo di consenso informato scritto: protocollo per l'utilizzo di Donatori affetti da meningite batterica, batteriemie o altre infezioni batteriche sistemiche.

Rete Nazionale trapianti. (2008). Modulo di consenso informato scritto: protocollo per l'utilizzo di Donatori a cui è stata diagnosticata una neoplasia in atto o pregressa.

Janz, N., Becker, M. and Hartman, P. (1984). Contingency contracting to enhance patient compliance: A review. *Patient Education and Counseling*, 5(4), pp.165-178.

De Jonge, E. T. M., Vlasselaer, J., Van de Putte, G., & Schobbens, J.-C. (2009). The construct of breast cancer risk perception: need for a better risk communication? *Facts, Views & Vision in ObGyn*, *1*(2), 122–129.

Vujicic, M.; Alfano, M.; Ryan, M.; Wesseh, C. S.; Brown-Annan, J. (2010). Policy Options to Attract Nurses to Rural Liberia : Evidence from a Discrete Choice Experiment. Health, Nutrition and Population (HNP) discussion paper*;*. *World Bank, Washington, DC. © World Bank.*

Determann, D., de Bekker-Grob, E., French, J., Voeten, H., Richardus, J., Das, E. and Korfage, I. (2016). Future pandemics and vaccination: Public opinion and attitudes across three European countries. *Vaccine*, 34(6), pp.803-808.

Alexander, N., Ross, J., Sumner, W., Nease, R. and Littenberg, B. (1996). The effect of an educational intervention on the perceived risk of breast cancer. *Journal of General Internal Medicine*, 11(2), pp.92-97

Determann, D., Lambooij, M., de Bekker-Grob, E., Hayen, A., Varkevisser, M., Schut, F. and Wit, G. (2016). What health plans do people prefer? The trade-off between premium and provider choice. *Social Science & Medicine*, 165, pp.10-18.

Anderson, D., Ben-Akiva, M. and Lerman, S. (1988). Discrete Choice Analysis: Theory and Applications to Travel Demand. *Journal of Business & Economic Statistics*, 6(2), p.286.

Determann, D., Lambooij, M., Steyerberg, E., de Bekker-Grob, E. and de Wit, G. (2017). Impact of Survey Administration Mode on the Results of a Health-Related Discrete Choice Experiment: Online and Paper Comparison. *Value in Health*, 20(7), pp.953-960.

Clark, M., Leech, D., Gumber, A., Moro, D., Szczepura, A., West, N. and Higgins, R. (2012). Who should be prioritized for renal transplantation?: Analysis of key stakeholder preferences using discrete choice experiments. *BMC Nephrology*, 13(1).

Frederick, S., Loewenstein, G. and O'donoghue, T. (2002). Time Discounting and Time Preference: A Critical Review. *Journal of Economic Literature*, 40(2), pp.351-401.

Nyberg, G., Blohme, I. and Norden, G. (1997). Gender differences in a kidney transplant population. *Nephrology Dialysis Transplantation*, 12(3), pp.559-563.

McGee, J., Magnus, J., Islam, T., Jaffe, B., Zhang, R., Florman, S., Hamm, L., Mruthinti, N., Sullivan, K. and Slakey, D. (2010). Donor-Recipient Gender and Size Mismatch Affects Graft Success after Kidney Transplantation. *Journal of the American College of Surgeons*, 210(5), pp.718-725.e1.

Weinstein, N. (2005). Smokers' unrealistic optimism about their risk. *Tobacco Control*, 14(1), pp.55-59.

O'Sullivan, O. P. (2015). The neural basis of always looking on the bright side. *Dialogues in Philosophy, Mental and Neuro Sciences,* 8(1):11–15

McKenna, F. (1993). It won't happen to me: Unrealistic optimism or illusion of control?. *British Journal of Psychology*, 84(1), pp.39-50.

Shepperd, J. A., Carroll P., Grace J., Terry M. (2002). Exploring the Causes of Comparative Optimism. *Psychologica Belgica*. 42: 65–98.

Jung, S. (2015). Does education affect risk aversion? Evidence from the British education reform. *Applied Economics*, 47(28), pp.2924-2938.