Identifying the Public's Knowledge and Intention to Use Human Cloning in Greek Urban Areas

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Purpose: The understanding of the public's knowledge on human cloning (HC) and its acceptability are considered important for the development of evidence-based policy making. The aim of this research study was to investigate the demographic and socioeconomic variables that affect the public's knowledge and intention to use HC in urban areas of Greece. Additionally, the possible association of religiousness with the knowledge and the intention to use HC were also investigated.

Methods: Individual interviews were conducted with 1020 men and women of urban areas in Greece. Stratified random sampling was performed to select the respondents. Several scientists, experts in HC, evaluated the content of the instrument initially developed. The final questionnaire was consequently the result of a pilot study.

Results: Almost half of the respondents (51.5%) believed that "HC is a sort of in vitro fertilization" and 42.9% that "it has already been applied to human being." They were not aware that "the cloned fetus grows in the woman's uterus" (41.5%) and that "HC could regenerate human organs" (41.7%). The acceptability of human cloning for the cure of terminal diseases and transplantation need is very high (70.7% and 58.6%, respectively). The public's intention to have recourse to cloning on the grounds of "bringing" back to life a loved person or because of reproductive disorders was reported as desire by 35% and 32.5%, respectively. The occupational category (scientists, self-employed, and artists), the intention to use HC, and the number of children are highly significant predictors of valid knowledge about HC. Low rates of church attendance appeared to relate with high reported intention to use HC, and increasing scores of valid knowledge about HC increased the public's intention to use HC.

Conclusions: A number of specific demographic and socioeconomic characteristics and high scores of knowledge provide a persuasive justification in demonstrating intention toward HC. The current study suggests that these findings should receive further attention by policymakers and scientists within the Greek context.

KEY WORDS: Acceptability; Greece; human cloning; intention; knowledge; understanding.

INTRODUCTION

In contemporary times there is definitely a widespread and intensive debate about human cloning

(HC) among several disciplines. HC has attracted substantial attention not merely from the biomedical sciences. In fact, a plethora of different disciplines, such as philosophy, law, policy, religion, journalism, and the social sciences are involved in the debate

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(1–4). Hence, a multidimensional approach from a variety of perspectives takes place.

However, it seems that the original research studies in HC are sporadic and limited, from the social sciences perspective, and since the issue was only recently introduced, the evidence in this domain remains seriously restricted. It has been claimed that more exploratory surveys in public perception of biotechnology should take place (5). Future researchers are invited to explore more useful generalisation on the particular topic (6).

Focusing particularly on Greece, it seems that the public's knowledge about HC has been poorly investigated, and very few, if any, studies exist currently on this topic. Furthermore, only two original studies carried out in Greece, in the wider field of biotechnology, explored the public's intention to use biotechnology. Specifically, it has been found that the population tends to accept reproductive technologies (7) although the perceived level of the public's knowledge about assisted reproductive technologies was low (8).

This study has been the first attempt to find out the existing knowledge of the Greek population and its intention to use HC in particular. Nevertheless, it is important to emphasize that this study aims at investigating public's knowledge and intention to use HC rather than get involved in the therapeutic and reproductive cloning debate. Finally it was within our purposes to provide policymakers with an evidence-base in order to acknowledge the needs of the Greek population and so they may subsequently design health promotion interventions regarding HC.

Moving beyond the well-known therapeutic and reproductive distinction of HC, a third dimension of HC came into sight, which is founded from personal ambitions to use HC as is explained in the following sections. Fundamentally, it rather sought to bring into light the overall knowledge of the Greek population, offering the respondents a large-scale closed-ended questionnaire. In this light, the study did not focus narrowly on a single dimension of any of the three aforementioned dimensions of HC.

Nevertheless, it was taken into account that HC has caused a wide range of reactions in public opinion that may affect public's intention to use HC. For instance, it has been shown that several populations across the globe demonstrate condemnation, suspicion, ambivalence, fear, and concerns about discrimination and privacy (1,5,6,9,10). HC was basically criticised on the grounds that it potentially dismantles social order and social norms (1,5). It may

also lead to the commercialization of genes with consequently complicated implications (11,12). There is therefore a strong disapproval from the public's perspective against HC. However, a shift in public response from repulsion to increasing endorsement has possibly arisen (13).

The benefits of HC seem to be acknowledged mostly from the scientific and academic community while little is known about the public's awareness of the beneficial aspect of HC. A series of benefits has been met in the literature, such as the extension of life expectancy, contribution in a higher quality of life and a contribution to health care (12), the alleviation of painful diseases, and the development of medicine in the future (14–18). Furthermore, therapeutic cloning may enhance human happiness (9,17). Taking into consideration the aforementioned benefits of HC, it is noteworthy that the public has been found to demonstrate mostly negative reaction toward HC.

On the other hand, it was within the purposes of this study to identify and assess the existing knowledge of Greek population about HC. Particularly, increased knowledge about HC appears to be associated with high levels of education. It is not the ignorance of certain religious groups that leads them to opposition to HC. On the contrary, it is the belief that they should keep science and religion apart (6). Therefore this research study aimed at investigating in Greece the knowledge of the homogeneous Greek Orthodox population. It is also remarkable that certain population groups such as students have been shown to have minimal understanding in terms of biotechnology, while concurrently there is a widespread confusion about HC among laymen (18). However, this study did not focus narrowly on any certain population group.

The debate on HC should be more open and honest and should definitely involve the public (15,16,19). Concurrently, little is known about public opinion in the particular field, although the news about human "reproductive cloning" has been broadly disseminated through the mass media (5,10,12,20,21). Suffice is to say that cloning was tremendously overpresented in media coverage when the birth of Dolly the sheep occurred in February 1997. Nevertheless, it is disputable whether the public has gained valid knowledge about cloning and whether the public is aware of the benefits and risks that cloning may arise for humanity.

Greece appears to lack political and legal experience in dealing with biotechnological matters (8,22).

However, a recent law enacted (3089/23-12-02) prohibits reproductive cloning but not therapeutic, leaving this option open for the future. In Europe normative disparity and legal ambiguity has led to a lack of consensus within the EU. On the grounds of social pluralism, the EU needs to reach a harmonization on the legal framework about HC (23). Frequently policymakers have disregarded the indications of public concern about HC (5).

Attention is drawn accordingly to the need for continued public discourse to concentrate on public's concerns about human genome project, including HC (10). Also, the need for enhancement of scientific literacy within schools is emphasized, as knowledge provides the basis for informed decision (18). Katayama appears to agree with this argument, stating that increased knowledge is associated with less fear and a more thoughtful approach (24).

The current study aimed at determining demographic and socioeconomic variables that affect public's knowledge on HC in urban areas of Greece. It was also worth investigating the contribution of public intention to use (acceptability of) HC in predicting its knowledge. Moreover, it was attempted to explore the impact of demographic and economic variables and knowledge on the intention to use HC. Finally, the possible association of religiosity with knowledge and intention to use HC was also examined.

METHODS

Description of the Study Sample

A probabilistic stratified random sampling was employed in order to draw the 1020 participants aged 18–65 from 18 municipalities of several urban areas in Greece. The procedure was carried out in accordance with the information and the instructions offered from the National Statistic Department. A two-staged conglomerate sampling was performed, with subsampling and stratification of the first units that were the censal sections in which the municipalities are divided. After the censal sections used for sampling had been chosen, all the households of these sections were counted, and the list of homes selected for the sample (two per censal section) was drawn by simple random sampling, without replacement, from the total list of homes. In case that in the same household several men or women were eligible to be interviewed, one of them was randomly selected on a number table. This sampling design ensured the demographic representativeness of the sample.

The variables used to stratify the sample to be selected were the following: sex, age, marital status, educational level, and occupation. In the case of this research study, after the above-described procedure took place, the sample of 1020 subjects was representative at the level of the 18 municipalities, and such representativeness refers to the results of the research in the specific study time period.

Methods for Collecting Information

The data was collected through personal interviews conducted by social workers (students of the 7th semester). The interviewers were controlled at each stage of the fieldwork aiming at preventing possible errors during data collection. For this purpose the following measures were taken: (1) use of a team of social workers who had received appropriate 16-h training and were supervised by the main researcher; (2) design of an easy-to-use questionnaire; (3) all the participants were thoroughly informed about the aims of the study and consent was obtained by all the respondents before the completion of the questionnaire; (4) instructions were given in detail on how to complete the questionnaire; (5) protection of subjects' anonymity and confidentiality; and (6) quality control by the validation of 10% of the completed questionnaires randomly selected. One of the key objectives was to avoid any possible fears and prejudices in filling in the questionnaires. The interviewers were therefore permitted to clarify any queries that the interviewees might have had while completing the questionnaire. The response rate was 90%.

Instrument and Measures

Initially, certain items were identified through the literature review that were considered appropriate to be investigated in this research study. Furthermore, the researchers had discussions with biomedicine specialists, theologians, and lawyers about a range of cloning aspects and about how HC could be perceived by the public in order to construct the instrument. Then, professors of medicine "experts" in biotechnologies, were asked to discuss the possible effects of HC to the society. These discussions formed the basis of the schedule questionnaire. A pilot study with a sample of 50 individuals preceded the current study. For the purposes of the pilot study, the interviewers used a questionnaire with open-ended questions referring to the intention of the respondents to use HC and to their knowledge on HC. Finally, several experts in HC evaluated

this instrument. The final questionnaire, used in the study, was subsequently the result of the pilot study.

Demographic and Socioeconomic Information. The final questionnaire was divided into three sections. The first section referred to the demographic characteristics of the individuals (sex, age, marital status, number of children), to the socioeconomic characteristics (educational level, occupation) and to religiosity. In this study religiosity was estimated by measuring the rate of the respondents' reported church attendance.

Knowledge on Human Cloning. The second section included 13 close-ended questions to record public's knowledge about the main dimensions of Cloning (e.g. "Cloning is applied merely to people," "It could help in the cure of incurable diseases," "The cloned embryo is created in scientific labs"). All these questions required answers: true/false/don't know. To each correct answer was given 1 mark. A score of "valid knowledge" was obtained by dividing the correct answers by the total of questions.

Intention to Use Human Cloning (Acceptability of HC). The third section included 10 items assessing subjects' intention to have recourse to HC by stating a series of reasons that explain this intention. In this sense, interviewees were asked to hypothesize that HC is currently an ordinary, legal, and technically feasible method. They were then invited to take into account personal emotions, beliefs, ideology, interests, etc., and indicate in which of those cases they may accept using human cloning. Examples of the statements were: "to bring back to life a loved person of mine," "to clone myself," "just curiosity," "due to the need for transplantation," "to cure incurable diseases," "due to reproductive disorders," etc. The answers ranged from 0 = no to 3 = Yes. The composite score of these 10 items formed the scale of the *Intention to use HC*, which could range from 0 to 30. Higher scores in the scale equate to stronger intention to use (acceptability of) HC. Responses to the 10 items were averaged to obtain the score on the scale. Its internal consistency, measured by Cronbach's alpha, was 0.78.

Statistical Analysis

The study employed two types of statistical analysis. The first measured the frequency of the items of the participants' *knowledge about HC* and their *Intention to use HC* that constituted the two outcome variables of the study. The mean values of the composite score for each variable according to the occu-

pational classes and the level of church attendance was presented. Second, to avoid confounders among predictive and outcome variables the data were modeled through two multiple linear regressions (forward stepwise technique). A number of demographic and socioeconomic characteristics data were entered into each of the regression equations, to measure their combined effects.

The first regression analysis was employed to assess the relationship among several independent/predictor variables and the outcome/dependent variable (the composite score of the rates of the *Valid knowledge about HC*). This equation controlled for a set of independent variables: (i) Demographic characteristics [gender, age in years, marital status, number of children (regrouped in two categories 0 = without children 1 = with more than one child)]. (ii) Socioeconomic characteristics including educational level (in years of education), and the occupational classes: (1) scientists, self-employed, artists; (2) traders, shop assistants, and officers, etc.; (3) blue collars; (4) housewives; (5) students, soldiers, etc. Students, soldiers, etc. has been used as a reference category in the analysis. (iii) Church attendance (summarized in two categories 1 = every Sunday 2 = never or sometimes). (iv) The scale of the *Intention to use HC*.

Similarly, the second regression analysis was used to assess the relationship among the same independent/predictor variables as to the previous model and the outcome/dependent variable (the scale of the *Intention to use HC*). *Valid knowledge about HC* was examined as a possible predictor variable.

In the regression models, with the use of the stepwise technique, are entered only the variables that could predict the dependent variable. All the other variables are excluded from the equation. Partial correlations are also presented in both models to underline the strength of each predictor after controlling for the effects of all the other predictors in the regression equation.

RESULTS

Demographic Characteristics

The sociological profile information and some other characteristics of the 498 (48.8%) men and 522 (51.2%) women are presented in Table I.

Knowledge on Human Cloning

All the answers given to the 13 items evaluating public's understanding of various dimensions of

Table I. Distribution of Study Subjects According to Demographic Characteristics, and Church Attendance

	Mean	SD
Age	32.7	11.9
Years of education	13.4	3.3
Number of children	.88	1.1
	<i>N</i>	%
Gender		
Male	498	48.8
Female	522	51.2
Occupation		
Scientists, self-employed, artists	272	26.6
Traders, shop assistants, officers	240	23.5
Blue collars	191	18.7
Housewives	136	13.3
Students, soldiers, etc.	179	17.9
Marital status		
Single	522	51.2
Married	423	41.5
Other	75	7.3
Church attendance		
Never	88	8.6
Occasionally (Christmas, Easter)	425	41.7
Sometimes during a semester	453	44.4
Every Sunday	54	5.3

human cloning are presented in Table II. The three most known items are the following: "HC is not applied merely to people" (91.4%); "it could help in perpetuation of uncommon species of animals and plants" (76.9%); "it is still in experimental stage" (69.8%). Almost half of the respondents (51.5%) believed that "HC is a sort of in vitro fertilization" and 42.9% that "it has been already applied to a human being." On the other hand the respondents are unaware that "the cloned fetus grows in the woman's uterus" (41.5%) and that "HC could help in the regeneration of human organs" (41.7%).

Table II. Distribution of the Recorded Knowledge of Human Cloning (%)

	True	False	Don't know
<i>Cloning...</i>			
Is applied merely to people	4.7	91.4	3.9
Is a sort of in vitro fertilization	51.5	30.0	18.5
Could help in the perpetuation of uncommon species of animals and plants	76.9	7.8	15.3
Is still in experimental stage	69.8	16.5	13.7
Could help in the cure of incurable diseases	61.2	9.8	28.9
Allows the selection of the child's features	71.3	11.2	17.5
Is achieved only through cells of a living being	42.6	25.8	31.6
Could regenerate human organs	43.7	14.5	41.7
It has been already applied to a human being	42.9	33.4	23.6
The cloned fetus grows in the woman's uterus	38.0	20.4	41.5
The cloned embryo is created in scientific labs	42.5	25.2	32.3
DNA of clone is different from donor's DNA	13.4	56.3	30.3
The cloned organisms get older earlier	41.0	8.4	50.6

Table III. Mean, Values and Standard Deviations of the Valid Knowledge Score According to the Occupational Classes and Level of Church Attendance

Occupation	<i>N</i>	Mean	SD
Scientists, self-employed, artists	272	6.02	2.04
Traders, shop assistants, officers	240	5.46	2.34
Blue collars	191	5.46	2.24
Housewives	136	5.74	2.58
Students, soldiers, etc.	179	5.65	2.05
Church attendance			
Never	88	5.56	2.01
Occasionally (Christmas, Easter)	425	5.72	2.23
Sometimes during a semester	453	5.77	2.26
Every Sunday	54	5.59	2.36

The Score of the Valid Knowledge on Human Cloning

The score of the *valid knowledge* varied from 1 to 13 with a mean value of 5.7 (SD 2.2). Additionally, mean values and standard deviations of the *valid knowledge* according to occupational classes and level of church attendance are shown in Table III.

Intention to Use Human Cloning

Percentages of acceptability or refusal to use HC are cited in Table IV. More specifically, the acceptability of HC is very high for the cure of incurable diseases and the transplantation need (70.7% and 58.6%, respectively). Public's intention to have recourse to HC on the grounds of "bringing" back to life a loved person or due to reproductive disorders was reported by 35% and 32.5%, respectively.

The score of the scale of the *Intention to use HC* varied from 0 to 28 with a mean value of 7.5 (SD 5.4). In Table V are presented the mean values and

Table IV. Distribution of Subjects' Responses Towards Human Cloning Intention (Acceptability of HC) (%)

	No	Probably No	Probably Yes	Yes
To clone myself	79.4	15.1	2.8	2.6
To meet my personal ambitions	79.4	13.5	4.6	2.5
Just curiosity	79.3	11.2	7.0	2.5
To have financial benefits from the use of my genetic material for the production of medicines and organ transplant	74.5	14.3	6.0	5.2
To bring back to life a loved person of mine	42.9	22.1	20.3	14.7
Because I am in the need for transplantation	27.4	13.8	34.2	24.6
For the cure of incurable diseases	18.8	10.5	35.8	34.9
To select the features of my clone	73.6	17.4	4.4	4.5
Because it is a technological achievement and I would like to try it	77.9	14.7	4.6	2.7
Due to reproductive disorders	49.6	17.6	21.8	10.7

standard deviations of the *Intention to use HC* according to the occupational classes and the level of church attendance.

Multiple Regression Analysis

The model included eight predictors that were selected according to theoretical, empirical, and collinearity criteria. The model was based on 1020 cases for which completed information on all nine variables existed (seven independents and an outcome).

The results of the multiple-regression concerning the composite score of *valid knowledge about HC* in a series of demographic and socioeconomic variables and in the scale of the *Intention to use HC* are cited in Table VI. The results from this model suggest that (a) the occupation, (b) the *Intention to use HC*, and (c) the number of children are highly significant predictors of *Valid knowledge about HC*. All other variables were excluded from the model as powerlessness to predict knowledge about HC. Thus, in this model, the regression coefficients and the standard errors of these significant variables are: occu-

pational class 0.40 (0.15), *Intention to use HC* 0.35 (0.13), and number of children 0.36 (0.14). Increasing scores of the scale of the *Intention to use HC* increased the public's information on HC. Regarding demographic and socioeconomic variables included in the model, the occupational class of scientists, the self-employed, and the participants who have at least one child seem to be better informed on HC topics.

A Model Explaining Significant Predictors of the Intention to Use HC. Similarly, Table VII provides the results that emerged from the multiple-regression concerning the scale of the *Intention to use HC* in a series of demographic and socioeconomic variables and in the composite score of the *valid knowledge about HC*. (a) Low rates of church attendance appeared to be correlated with high reported acceptability of HC (regression coefficient -2.74 and standard error 0.76). (b) Participants without children are more willing to use HC (regression coefficient -1.10 and standard error 0.34); (c) Increasing scores of *Valid knowledge about HC* increased the public's *Intention to use HC* (regression coefficient 0.20 and standard error 0.07).

DISCUSSION

Human cloning is a relatively new issue introduced in the agenda. However, when HC appeared on the scene, it immediately generated a heated controversy among scientists, policymakers, ethicists, journalists, and religious leaders. At the same time HC is accompanied by arguments about privacy and discrimination (10,17) as well as that HC goes beyond what is permissible for humans (6) and is "against nature" (5). On the other hand, the supporters of HC recognize that it promises great advances in contemporary biomedicine and consequently it may

Table V. Mean, Values and Standard Deviations of Human Cloning Intention (Acceptability of HC) According to the Occupational Classes and Level of Church Attendance

Occupation	N	Mean	SD
Scientists, self-employed, artists	272	7.44	5.28
Traders, shop assistants, officers	240	7.12	5.59
Blue collars	191	7.26	5.63
Housewives	136	7.46	6.10
Students, soldiers, etc.	179	8.49	4.99
Church attendance			
Never	88	8.19	6.35
Occasionally (Christmas, Easter)	425	7.55	5.04
Sometimes during a semester	453	7.70	5.74
Every Sunday	54	4.48	4.22

Table VI. Stepwise Multiple Regressions—Derived Regression Coefficients and *P* Values of Reported Scores of the Valid Knowledge of Human Cloning

Variables	<i>b</i>	SE (<i>b</i>)	Partial correlations	<i>P</i> value
<i>Constant term</i>	5.20	0.14		0.000
Socioeconomic variables (Occupation)				
Scientists, self-employed, etc.	0.40	0.16	0.122	0.010
Students, soldiers, etc (baseline)				
<i>Intention to use human cloning</i>	0.35	0.01	0.186	0.006
Demographic variables				
Having at least one child	0.36	0.14	0.101	0.010
Without children (baseline)				

lead to the prolongation of human life and a better quality of life (14,16).

The questions that arise therefore are: how the public perceives this new scientific achievement; what does the public know about HC; and whether it intends to use or not HC under certain given circumstances, which indicates eventually its acceptability toward HC.

In brief, this study focused firstly on finding out the valid knowledge and the acceptability that Greek population may have concerning HC. Secondly, it sought to identify predictors of the valid knowledge taking into account demographic and socioeconomic characteristics and the acceptability of HC. Thirdly, an attempt was made to search for powerful predictors of the acceptability of HC among demographic and socioeconomic characteristics and valid knowledge about HC. Accordingly, the findings of this study concerning valid knowledge about HC seem rather disappointing. Only a small percentage (5.7%) was found to own correct information and understanding of HC (see Table III), while the majority (48.9%) of the participants answered less than half of the questions correctly. This finding brings into light the alarming public's unawareness about HC despite the overpresentation of the issue when it was firstly introduced in 1997.

Likewise, it has been shown that Spanish population has a relatively poor knowledge of biotechnol-

ogy (25). This comes in accordance with the findings emerging from the current study. On the contrary, British investigators reported sufficient understanding of new genetics (26). Also a survey carried out in Japan reported a very high level of public awareness of human genetic manipulation and a relatively low, although increasing, acceptance of gene therapy (27). It is therefore important to seek the features of each society that play a role in public's knowledge about new biotechnology including HC. The similarity of the findings between the Greek and the Spanish populations may reveal common characteristics of the two Mediterranean populations. Comparative studies may therefore shed more light on the situation.

In the current analysis, the acceptability of HC at both individual and social level was also investigated. The results demonstrate explicitly (Table IV) that the respondents would not use the applications of HC either for commercial reasons or prompted by curiosity. As a matter of fact, HC has been presented to the public as a scientific triumph that is often challenging for public consciousness. It might be tempting to replicate oneself or create the identical replication. However, Greek society appears to strongly reject these perspectives. In contrast, the participants of this study seem more likely to use HC for therapeutic reasons, such as the cure of terminal diseases, while they seem skeptical for its reproductive use. Specifically, a minority of the participants

Table VII. Stepwise Multiple Regressions—Derived Regression Coefficients and *P* Values of the Scale of the Intention to Use Human Cloning

Variables	<i>b</i>	SE	Partial correlations	<i>P</i> value
<i>Constant term</i>	6.97	0.48		0.000
Church attendance frequency				
Every Sunday	−2.74	0.76	−0.182	0.000
Never or sometimes (baseline)				
Demographic variables				
Having at least one child	−1.10	0.34	−0.100	0.001
Without children (baseline)				
Valid knowledge rate	0.20	0.07	0.183	0.008

(10.7%) would use cloning for reproductive purposes, whereas a remarkable majority (49.6%) totally rejects HC as a possible solution to reproductive problems. It is also worth noting that the rest of the respondents face the dilemma in a more comprehensible approach.

These findings come in relative accordance with other studies where therapeutic cloning has gained more support compared to reproductive cloning (9). For instance, human reproductive cloning was rejected on the grounds that it promotes genetic discrimination as it allows the replication and creation of desired human types (28). According to Mathuna it is still debatable in the United States whether research on therapeutic cloning should be allowed, while a ban of reproductive cloning is definitely expected (11). These theoretical analyses are often considerably disseminated through the mass media and they may shape public's opinion, taking into consideration the inadequacy of media to report objectively the ethics of cloning (28). On the other hand though Zavos emphasize the need to take more seriously the potential benefits of cloning on assisted reproduction and provide the public with the adequate and valid information in order to avoid confusion (16). Illmensee also offers a thorough and balanced review on HC addressing the advantages and possible dangers of it prompting the reader to take a more moderate and sophisticated approach to the topic (15). These accounts contribute significantly to the balance of argumentative that constitutes the prerequisite of a deeper understanding of the topic.

Regarding predictor factors of valid knowledge, occupation appears to have a strong association (Table V). Particularly, it has been shown that professions falling in the first category, which consists of scientists, self-employed, and artists, seem to have got higher valid knowledge about HC, compared to students and other professional categories. Not surprisingly this study confirmed the argument that more educated people are more likely to be familiar with HC (6,24). Concerning social status, it is interesting to note Evans' argument that there is a relationship between higher educational level and more liberal attitudes toward cloning (6). However, it was beyond the purposes of this study to analyze the attitudes of Greek population toward HC, although it will be analyzed shortly in a subsequent study. Nevertheless, the aforementioned finding highlights the need for greater emphasis in scientific literacy in the school curriculum, since young people have been shown to lack valid knowledge about HC.

Indeed, there is a widespread concern about scientific education on HC and biotechnology in a broader sense (5,18,25). The need for the enhancement of scientific literacy becomes more obvious taking into consideration the rapid development of biotechnology, including HC. Students have been shown to have a seriously limited knowledge of biotechnology and they therefore make recommendations about the improvement of scientific literacy across the school curriculum (18). This study confirmed that new generation lacks knowledge on HC and therefore has the right to receive more education about the contemporary biotechnologies and specifically HC in order to prevent massive ignorance and enhance informed-choices in the future.

Currently the mass media play the role of the main vehicle that disseminates information on HC, despite scientists' unwillingness to see their work on a public stage (21). Thus, not only schools, but also the mass media should assume responsibility in providing to the audience better quality of information about HC. This seems particularly important in Greece where health promotion is still in its early steps and there is inevitably a lack in designing mass media campaigns. Taking into account the newly introduced issue of HC, the still weak role of health promotion and the challenging nature of this issue itself, it explains why there is a shortage of mass media campaigns. Needless to say, mass media campaigns contribute in raising consciousness about HC and conveying simple information about HC.

One implication deriving from relevant findings of other studies is the difficulty that policymakers encounter in dealing with public concerns about some of the biotechnological achievements (5). On the other hand, policy makers reacted spontaneously to the public's panic when HC was firstly presented through the media and they placed a series of bans on scientific research on HC (4). It has been emphasized that public deserves an opportunity to play a role in framing the rules (19). Similarly, lack of public debate leads to a shortage of public's adequate knowledge about biotechnological issues (25). Consequently, policy institutions in Greece and elsewhere—if similar findings have been demonstrated—should take into account the public's lack of adequate knowledge and they should also underpin the implementation of mass media campaigns and the enhancement of scientific literacy through several institutions. Certainly more up-to-date original research studies should be carried out in order to measure the current public's knowledge

and acceptance of HC since the time period from 1997 to 2003 may have contributed to a substantial shift.

The present analysis reveals another interesting point. The respondents who have at least one child are more likely to show increased valid knowledge of HC. It seems that the respondents who are parents are more familiar with contemporary reproductive techniques and achievements including HC. Consequently, information campaigns should be tailored upon the needs of people who are not parents yet. On the other hand, people with at least one child under 18 at home are likely to be opposed to cloning (6). However, this survey did not deal with investigating the parents' attitudes toward HC. A following study will focus on public's attitudes toward HC and in that study it will be examined whether parents are opposed or not to HC.

Additionally, according to the results of the current analysis, religiosity was found to have a negative impact on the intention to use HC. Specifically, people who reported church attendance rarely or never were those who expressed increased acceptability of HC. In contrast, respondents who identified themselves as more religious are more likely to report low rates of acceptability of HC. Similarly, the Christian population expresses an overall condemnation of HC, although Greek Christian Orthodox respondents were not included in the study (6). Hence the present study introduces new findings regarding religious identity and intentional behavior toward HC. It seems that people who follow the principles of Greek Christian Orthodox dogma seem hostile to new biotechnologies and particularly to HC (8). It is suggested therefore that the Greek Orthodox Ecclesia should encourage its laymen to recognize the possible benefits of cloning and to make a more realistic approach to cloning which would not be in contrast to their convictions.

The intention to use HC and the acceptability therefore that this population expressed of HC is influenced by having at least one child. Thus, participants who have offspring are less likely to demonstrate acceptability of HC (6). On the contrary, the participants who do not have offspring yet appear more willing to use HC for reproductive purposes. This finding seems in agreement with previous research in Greece about assisted reproductive technologies (8). Possibly it indicates that people without children are more in doubt about their biological capacity to become parents. They therefore take into consideration the biotechnological

achievements when they are in front of the dilemma of not acquiring offspring or use biotechnology.

Finally, this study revealed the relationship between valid knowledge and acceptability of HC. Particularly, increased valid knowledge was found to be associated with higher levels of intention to use HC. This result confirms the argument that the more people know about a topic the less they fear it and they are more likely to engage in more thoughtful approaches to it (24). On the contrary, genetic understanding has no association with encouragement of cloning (5). Investigating public's attitudes toward HC may assist exploring public's perceptions of biotechnology as a whole. Further research with common instruments is needed in order to measure knowledge of HC at the international level (5).

This study may be a good starting point for future research in Greece. Hence, it is recommended that further research take place in Greece in the future to find out whether any changes in public's knowledge of HC will have occurred. Particularly, longitudinal studies should take place to estimate possible changes on the topic. The present study offers the basis for subsequent research in identifying and assessing the needs of Greek population in terms of knowledge and intention toward HC.

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REFERENCES

1. Jasanoff S: The life sciences and the rule of law. *J Mol Biol* 2002;319:891-899
2. Etkin LD: The debate about human cloning. *Differentiation* 2002;69:145-146
3. Pattinson SD: Reproductive cloning: Can cloning harm the clone? *Med Law Rev* 2002;10:295-307
4. Neresini F: And man descended from the sheep: The public debate on cloning in the Italian press. *Public Understanding Sci* 2000;9:359-382
5. Einsiedel EF: Cloning and its discontents—a Canadian perspective. *Nat Biotechnol* 2000;18:943-944
6. Evans JH: Religion and human cloning: An exploratory analysis of the first available opinion data. *J Sci Stud Religion* 2002;41(4):747-758
7. Chliaoutakis JE: A relationship between traditionally motivated patterns and gamete donation and surrogacy in urban areas of Greece. *Hum Reprod* 2002;17(8):2187-2191
8. Chliaoutakis JE, Koukouli S, Papadakaki M: Using attitudinal indicators to explain the public's intention to have

- recourse to gamete donation and surrogacy. *Hum Reprod* 2002;17(11):2995–3002
9. Burley J: The ethics of therapeutic and reproductive human cloning. *Cell Dev Biol* 1999;10:287–294
 10. Tambor ES, Berhardt BA, Rodgers J, Holtzman NA, Geller G: Mapping the human genome: An assessment of media coverage and public reaction. *Genet Med* 2002;4(31):31–36
 11. O' Mathuna DP: What to call human cloning. *EMBO Rep* 2002;3(6):502–505
 12. Everett M: The social life of genes: Privacy, property and the new genetics. *Soc Sci Med* 2003;56:53–65
 13. Maienschein J: On cloning: Advocating history of biology in the public interest. *J Hist Biol* 2001;34:423–432
 14. Finkler K, Skrzynia C, Evans JP: The new genetics and its consequences for family, kinship, medicine and medical genetics. *Soc Sci Med* 2003;57:403–412
 15. Illmensee K: Cloning in reproductive medicine. *J Assist Reprod Genet* 2001;18(8):451–467
 16. Zavos PM: Human reproductive cloning: The time is near. *BioMed Online* 2003;6(4):397–398
 17. Reiss MJ: Ethical dimensions of therapeutic human cloning. *J Biotechnol* 2002;98:61–70
 18. Dawson V, Schibeci R: Western Australian school students' understanding of biotechnology. *Int J Sci Educ* 2003;26(1):57–69
 19. Kirkman C: Proposed regulation of human cloning: Paving the way for degenerative disease therapeutics. *DDT* 2001;6(18):919–920
 20. Sanchez-Sweatman LR: Reproductive cloning and human health: An ethical, international, and nursing perspective. *Int Nurs Rev* 2000;47(1):28–39
 21. Priest SH: Cloning: A study in news production. *Public Understanding Sci* 2001;10:59–69
 22. Mavroforou A, Giannoukas A, Michalodimitrakis E: A review of Greek law on human cloning. *Med Law* 2003;22(1):55–62
 23. Romeo-Casabona CM: Embryonic stem cell research and therapy: The need for a common European legal framework. *Bioethics* 2002;6(6):557–567
 24. Katayama A: Human reproductive cloning and related techniques: An overview of the legal environment and practitioner attitudes. *J Assist Reprod Genet* 2001;18(8):442–450
 25. Lujan JL, Moreno L: Public perception of biotechnology and genetic engineering in Spain: Tendencies and ambivalence. *Technol Soc* 1994;16(3):335–355
 26. Human Genetics Commission: Public attitudes to human genetic information: People's Panel Quantitative Study conducted for the Human Genetics Commission, London (2001), Human Genetic Commission, 68 leaves, HD Hum, www.servicefirst.gov.uk/2001/panel/hgc/index.htm
 27. Macer DRJ: Public acceptance of human gene therapy and perceptions of human genetic manipulation. *Hum Gene Ther* 1992;3:511–518
 28. Best S, Kellner D: Biotechnology, ethics and the politics of cloning. *Democracy Nat* 2002;8(3):439–465