Assessment of public perception regarding wastewater reuse

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Abstract A descriptive-correlational study was recently conducted in a four county metropolitan area in the southeast United States (US) as part of a collaborative effort between nursing and environmental engineering researchers. The purpose of the study was to assess attitudes, knowledge and information sources concerning wastewater reuse and evaluate the results with respect to population demographics. The study indicated that both men and women unfavorably view the use of wastewater for possible consumption (released into potable surface or groundwater supplies) or applications involving close, personal contact (laundry). Women were especially concerned about pumping wastewater into the groundwater for subsequent potable use. Both genders felt that wastewater reuse for applications not involving close personal contact (such as firefighting, car washing, lawn irrigation and agricultural uses) was acceptable. General knowledge concerning wastewater reuse was mixed. Those with lower incomes, less education, and 65 years of age or older had significantly less knowledge of this issue than younger, more educated, higher income individuals. Primary sources of information for most demographic groups included newspaper and television, although the Internet was identified as a frequent source for selected groups.

Keywords Population demographics; public perception; wastewater reuse

Introduction Society produces large volumes of treated municipal wastewater (reclaimed water) that require effective management to mitigate detrimental public health and environmental consequences. The quantity of municipal waste generated is projected to increase as sewers serve larger populations and as higher levels of wastewater treatment are introduced. Over the last decade, a shift away from waste disposal and toward beneficial reuse of reclaimed water has occurred. The number of programs established by municipalities and utility districts to manage these treated wastes as potential resources has increased dramatically due, in part, to beneficial use criteria promulgated by the US Environmental Protection Agency (EPA).

Increasing demands on water resources for domestic, commercial, industrial, and agricultural purposes have made wastewater reclamation an attractive option for conserving and extending available water supplies. Additionally, wastewater reuse can result in significant energy savings (particularly in arid regions) through reduced pumping of clean water from distant sources.

Expanded reuse operations have increased the public visibility of this waste management program; however, many municipalities are finding it more difficult to gain public acceptance of waste reuse projects. Vocal opposition and media attention have, at times, spawned sensationalized and misleading claims. Some utilities have financed and built facilities that cannot be operated in the face of community opposition. Lawsuits have alleged that reclaimed water results in a range of impacts including human and animal health problems. Public concerns about real or perceived risks weigh against the use of
reclaimed water. Decision-making is often driven more by public perception of risks rather than a scientific risk assessment.

The acceptance of reclaimed water must be comprehensively addressed if these resources are to become an integral component of waste management and sustainable community strategies. Public awareness efforts based solely on scientific data do not necessarily increase public acceptance of projects. Public policy on wastewater reuse options must include the human dimension since it is the public who will be served by, and pay for, the option. Determinants associated with waste management issues are complex but this does not lessen the importance of fully understanding these concerns if interventions are to be successful. The challenge is to identify public knowledge and perceptions and systematically address concerns through a framework of educational, policy and management strategies. This study attempted to assess public perception of wastewater reuse, determine the overall level of wastewater knowledge and identify information sources utilized to obtain environmental information.

Methods
Design
The research was a descriptive correlational study of the public knowledge, attitudes and information sources concerning wastewater reuse. A telephone survey instrument was developed to assess these parameters along with selected demographic characteristics. Data was subjected to SPSS multivariate statistical analysis to maximize the utility of the research for multiple subsets of the sample community. Descriptive analysis was conducted on the total sample for major study variables.

Target population and setting
The target population was adults living in a four county metropolitan area in the southeast US. The area encompasses both urban and rural locations and is a community where wastewater recycling has not yet been implemented.

Sample
Adults (N = 303) voluntarily participated in the telephone study. The four areas were selected to give a more diverse sample and to provide a cross section of gender, socioeconomic status, and educational experience.

Data collection procedures
Extensive peer review and revision of the survey questionnaire was performed to ensure that the vocabulary was appropriate for general sampling. The instrument included questions designed to measure attitudes, knowledge and information sources concerning recycled wastewater. Random digit dialing software and computer assisted telephone interview (CATI) software were used to facilitate the sampling and interview process. Surveys, conducted at a time known to be best for optimal participation, averaged less than eight minutes per respondent.

Results and discussion
Demographics
The telephone survey was conducted during a two-week period in February 2002. Demographic information for the 303 respondents has been summarized in Table 1. A higher percentage of females, 60.1% (N = 182), was represented in the study compared to males, 39.9% (N = 121), which is typical of telephone surveys. The sample group was primarily white (88.4%, N = 268) with small percentages of black (5.3%, N = 16), Hispanic
Asian (1%, \(N = 3\)), and American Indian (0.7%, \(N = 2\)) respondents. Due to the lack of ethnic representation, this parameter was not specifically evaluated in the study. Additionally, the annual household income of the sample group was fairly evenly distributed.

### Attitudes related to wastewater reuse

Descriptive statistics for wastewater attitudes were assessed for eight different wastewater reuse options. To better visualize attitudinal response toward wastewater reuse, the 5 point Likert scale was subsequently collapsed into three groups; disagree, neither disagree nor agree, and agree. Figure 1 shows that a majority of respondents have a positive attitude toward five wastewater reuse options (firefighting, golf course irrigation, lawn irrigation, car washing and agricultural irrigation). Among these five options, four received 75–85% overall agreement (the exception was agricultural irrigation, 58%). Discharging reclaimed water directly into a surface reservoir or into the groundwater (an indirect drinking water supply) elicited disagreement by 78% of the respondents (mostly in the form of strong disagreement). Laundry use of recycled wastewater was, to a lesser extent, unfavorably perceived (54% disagreement). Although respondents were generally supportive of many water reuse options, attitudes were less favorable to the more direct, personal contact options (laundry, groundwater recharge, and reservoir discharge). Indeed, the drinking water consumption options (groundwater recharge and reservoir discharge) incurred the strongest opposition of all the choices presented.
Attitudes concerning wastewater reuse (demographic analysis)

Multiple analysis of variance (MANOVA) was used to determine whether respondents differed on attitudes concerning the eight wastewater reuse options based on their demographic characteristics (gender, age, educational level, and household income).

Gender. Mean scores for recycled wastewater options are illustrated in Figure 2. Attitude scoring for different uses of recycled wastewater was computed using a 5-point Likert scale (1 = strongly disagree, 5 = strongly agree). Overall, means indicated that both male and female respondents felt unfavorable toward using reclaimed water in reservoirs and groundwater and less favorable toward laundry use than the other 5 options identified. However, women \( (F = 9.21, p = 0.003) \) were significantly less favorable to recycled wastewater pumped into groundwater for subsequent use as a drinking water supply.

Age. Five age categories were used in the survey (18–24, 25–34, 35–49, 50–64, and ≥65); however, the 18–24 group resulted in only 20 responses. Therefore, the two youngest age groups were collapsed for statistical purposes. Although multivariate tests for wastewater recycling showed no significant differences for age, mean values for the ≥65 age group were consistently lower (stronger disagreement) than other age categories for many of the options (Figure 3).

Figure 1 Attitudes toward wastewater reuse options

Figure 2 Attitudes toward wastewater reuse by gender (mean <3, = 3 and >3 indicate negative, neutral, and positive attitudes, respectively)
**Education.** Five educational categories were used in the survey (did not complete high school, graduated from high school, completed some college or university, graduated from college or university, and completed Masters degree or higher); however, the “did not complete high school” group resulted in only 24 responses. Therefore, this group was collapsed with the “graduated from high school” group for statistical purposes. Significant differences were noted by education level ($F = 1.83, p = 0.025$) in the MANOVA test for attitudes about using recycled wastewater. Those who attended or graduated from college (undergraduate or graduate degree) were more favorable to wastewater reuse, overall, than those with a high school education or less.

**Income.** Four annual household income categories (in US dollars) were used in the survey (<$25,000, $25,000–$50,000, $50,000–$100,000, and >$100,000); however, the >$100,000 group resulted in few responses. Therefore, this group was collapsed with the “$50,000–$100,000” group for statistical purposes. No significant differences in attitude on any wastewater reuse option among the three income levels were noted.

**Knowledge**

Knowledge concerning the three wastewater questions asked was mixed. Most people (80%) did not know that the average per capita amount of wastewater produced each day in the USA was greater than 100 L/d. However, a majority of respondents (70.5%) correctly answered that wastewater treatment meets US federal regulations for protection of public health. About 50% of respondents knew that groundwater contamination (via agricultural irrigation of reclaimed water) could be prevented by advanced wastewater treatment.

Table 2 depicts the differences among gender, income, age, and education on knowledge about wastewater generation and use. The MANOVA found significant differences on two of the three wastewater questions among the respondents who answered questions incorrectly. For the “contamination of groundwater” question, those with lower income, those with less education, and those over 65 years of age were less likely to answer the question correctly. For the “methods of treatment meeting federal regulations” question, those 65 years of age and older and those less educated were less likely to answer the question correctly. Results indicate that less education, lower income, and increased age correlate with less knowledge about wastewater recycling.
Information sources
In this study, respondents were surveyed regarding eight information sources utilized to access information about environmental issues: newspapers, television, Internet, governmental agencies, local utilities, universities or other academic organizations, friends/family, and environmental groups. For each source, the respondent was asked to determine frequency of use (frequently, sometimes or never). The most frequently used information sources were the newspaper and television (Figure 4). Approximately 50% of the respondents frequently used these sources for their environmental news. The Internet and friends/family members were used as frequent information sources by approximately 22% of the people surveyed. The remaining four sources were less commonly utilized for information (<15% selected them frequently).

There were many (46.5–53.2%) who reported that they “never” use five of the sources (Internet, governmental agencies, local utilities, universities, and environmental groups). In general, most people surveyed rely on the television and newspaper as their main information sources for environmental issues. The Internet had a relatively high “frequently” response but also had a high “never” response indicating that the Internet as an information source may be limited by accessibility. Other sources which received a high “never” response may also have the problem of accessibility. For example, direct information from universities, utilities, governmental agencies and environmental groups may be difficult to obtain unless one is directly linked to those entities.

Information sources (demographic analysis)
Gender. The $\chi^2$ statistical tests indicated that females were significantly more likely than males to frequently use the newspaper as an information source.

<table>
<thead>
<tr>
<th>Source</th>
<th>Gender $p$</th>
<th>Income $p$</th>
<th>Age $p$</th>
<th>Education $p$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amount of wastewater produced</td>
<td>0.174</td>
<td>0.285</td>
<td>0.778</td>
<td>0.452</td>
</tr>
<tr>
<td>Contamination of groundwater</td>
<td>0.312</td>
<td>0.003**</td>
<td>0.001**</td>
<td>&lt;0.001**</td>
</tr>
<tr>
<td>Methods meet federal regulations</td>
<td>0.101</td>
<td>0.347</td>
<td>0.032*</td>
<td>0.008**</td>
</tr>
</tbody>
</table>

*Significant at $p = 0.05$, **Significant at $p = 0.01$

Figure 4 Information sources utilized for environmental information
Age. Results indicated that the 18–24 and 25–34 age groups were less likely to frequently use the newspaper as an information source, while the 50–64 age group relied more heavily on the newspaper. Internet usage as the primary information source was more prevalent with the 35–49 age group and least prevalent in those 65 years and older. In general, the older respondents relied on traditional information sources such as the newspaper and television, whereas the younger respondents obtained information from a broader array of sources.

Education. Results indicated that the respondents who had not graduated from high school or possess a high school degree use the newspaper, Internet and governmental agencies less frequently for their environmental news than respondents with at least some college experience. Those who have completed college or graduate school report the most frequent use of the Internet for environmental information. Additionally, it appears that more educated adults utilize a broader array of information sources.

Income. Significant differences were noted among annual household incomes in the selection of information sources. In general, respondents with annual incomes less that $25,000 did not utilize newspapers, the Internet or environmental agencies for environmental information as frequently as respondents in the higher income brackets. Those with annual incomes $\geq$ $100,000$ report the most frequent use of the Internet. Additionally, fewer information sources are utilized by the lowest income group.

Conclusions
The study indicated that both men and women unfavorably view the use of wastewater for possible consumption (released into potable surface or groundwater supplies). Women were especially concerned about pumping wastewater into the groundwater for subsequent potable use. The use of wastewater for an application involving close, personal contact (laundry) was viewed unfavorably by both men and women. Both genders felt that wastewater reuse for applications not involving close personal contact (such as firefighting, car washing, lawn irrigation and agricultural uses) was acceptable. General knowledge concerning wastewater reuse was mixed. Those with lower incomes, less education, and 65 years of age or older had significantly less knowledge of wastewater issues than younger, more educated, higher income individuals. The primary source of information for most demographic groups was the television, with the newspaper identified as a frequent source of information also. The Internet was identified as a frequent source for selected groups; however, many respondents indicated that they never used the Internet. It appears that different media should be considered in developing programs for the various demographic groups. For example, information campaigns designed to reach the elderly population should include television as the primary medium. However, since this study was conducted in only one section of the US, results may not be generalizable to other areas of the country. In addition, cultural groups were not evenly distributed in the region surveyed, and consequently, not equally represented in the study.