International Journal of Internet Science
2007, 2 (1), 59-82

International Journal of Internet Science

IJIS.NET

Response Rates and Mode Preferences in Web-Mail Mixed-Mode Surveys: A Meta-Analysis

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Abstract*:* This meta-analysis examined (1) mode preference (i.e., response rate difference) between mail and Web survey modes in 43 mixed-mode surveys, and (2) the overall response rate in 52 Web-mail mixed-mode survey study results. Six study features were coded as potential factors that might contribute to the variation in the outcome variables (mode preference, and overall response rate) across the studies. Random-effect model analysis (forest plot) for mode preference indicates that, in general, mail survey mode was preferred over Web survey mode, but there was considerable variation in mode preference across these studies. All six study features were shown to contribute to the variation of mode preference across the studies. General linear model analysis for the outcome variable of overall response rate across these mixed-mode survey studies reveals that the six study features were statistically associated with the variation in the overall response rates across these mixed-mode survey studies. These findings are discussed, and some limitations of this study are noted.

Keywords: Web survey, mail survey, response rate, mixed-mode, option, meta-analysis

Introduction

There has been some concern about the Web survey's lower response rate than, say, more conventional mail survey (Couper, Blair, & Triplett, 1999; Dillman, Phelps, Tortora, Swift, Kohrell, & Berck, 2001; Sheehan, 2001). To obtain higher response rates, mixed-mode design has been suggested (Groves, Fowler, Couper, Lepkowski, Singer, & Tourangeau, 2004). In a mixed-mode survey, potential participants are offered more than one response options (e.g., Web survey mode or mail survey mode). Presumably, mixed-mode design could overcome some limitations of one single survey response mode, thus having the potential for achieving higher survey response rate.

Traditionally, large-scale mixed-mode surveys, such as *American Community Survey*, used mail, telephone call, and personal visit to collect data. With the development of Web survey methodology, mixed-mode surveys that include Web survey mode have become increasingly popular (Biemer & Lyberg, 2003; Christian, Dillman, & Smyth, 2005; De Leeuw, 2005). Although early mixed-mode surveys often used telephone survey as an alternative mode to mail survey (Dillman & Tarnai, 1988), the emergence of Internet use has led to the popularity of Web survey as a viable alternative in mixed-mode survey practice (Griffin, Fischer, & Morgan, 2001).

Two major potential benefits of mixed-mode surveys have been discussed. First, mixed-mode survey design may increase participation because people may appreciate being able to choose their preferred response modes

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(Dillman, 2000; Schaefer & Dillman, 1998). Some research suggests that individuals have different mode preferences (Groves & Kahn, 1979), and providing alternative response modes may be an effective way of improving response rates (Shettle & Mooney, 1999). Mixed-mode design is potentially capable of accommodating these personal preferences, thus leading to non-response reduction (Dillman & Tarnai, 1988). Second, cost consideration for data collection has led researchers to consider using different survey response modes as a way for reducing survey cost. Including the Web survey mode in a mixed-mode survey has been considered as a strategy for cost reduction (Dillman, 2000; Schaefer & Dillman, 1998). The emergence of Internet and Web survey has led numerous studies to combine Web and mail surveys to examine two important aspects: mode preference (i.e. the response rate difference between Web and mail survey modes), and the overall response rate. These studies provide the opportunities to understand the advantages and disadvantages of Web-mail mixed-mode surveys, and to explore some potential factors that may affect mode preferences and overall response rates.

Importance of Survey Response Rate

The computation of response rate is often inconsistent across studies because each study may use its own definition of response rate. As Groves and Lyberg (1988) noted, "there are so many ways of calculating response rates that comparisons across surveys are fraught with misinterpretations" (p. 195). In order to make reasonable comparisons across different studies, it is important to standardize the computation of response rate. This meta-analysis adopts the computation of *minimum response rate* as shown below which is defined as RR1 in the Standard Definitions of Outcome Rates for Surveys (American Association for Public Opinion Research, 2006):

$$RR1 = \frac{I}{(I+P)+(R+NC+O)+(UH+UO)} \qquad (1.0)$$

where, RR1 = Minimum response rate, I = Complete survey, P = Partial survey, R = Refusal and break-off, NC = Non-contact, O = Other, UH = Unknown if household/occupied housing unit, and UO = Unknown, other.

The *minimum response rate* in Equation 1.0 provides an estimate of response rate that is not overly optimistic. Essentially, this response rate is the ratio of number of completed surveys (*I*) to the number of total surveys sent out [(*I*+*P*) + (*R*+*NC*+*O*) + (*UH*+*UO*)]. Following Equation 1.0, the overall response rate (*RRO*) used in this paper is expressed in Equation 1.1 as shown below, the response rate of Web survey mode (*RRW*) expressed in Equation 1.2, and the response rate of mail survey mode (*RRM*) in Equation 1.3. As a result, the overall response rate of a mixed-mode survey is the sum of response rates from Web survey modes and mail survey modes.

$$RRO = \frac{Number\ of\ Completed\ Surveys}{Number\ of\ Total\ Surveys\ Sent\ Out} \qquad (1.1)$$

$$RRW = \frac{Number\ of\ Web\ Surveys\ Obtained}{Number\ of\ Total\ Surveys\ \ Sent\ Out} \qquad (1.2)$$

$$RRM = \frac{Number\ of\ Mail\ Surveys\ Obtained}{Number\ of\ Total\ Surveys\ \ \ Sent\ Out} \qquad (1.3)$$

To illustrate three equations above, in a hypothetical mixed-model survey, the survey notification was sent out by mail that contains both actual survey form and a Web URL for Web survey; any potential respondents may choose which mode (mail or Web) to use. If 1,000 surveys were sent out, and we received 300 mail surveys, and 200 Web surveys, we would have:

RRO = 500 / 1000 = 0.50 (or: *RRW* + *RRM* = 0.20 + 0.30 = 0.50)
RRW = 200 / 1000 = 0.20
RRM = 300 / 1000 = 0.30

The computation of *minimum response rate* requires the information that is common and can be obtained from all our collected studies, because every study recorded the number of surveys initially sent out (i.e. the denominator in Equation 1.0) and the number of completed surveys returned (i.e. the numerator of Equation 1.0) for its own analyses. Such use of minimum response rate not only avoids possible miscalculations of eligible survey cases and cases of unknown eligibility, but also makes response rates comparable across studies and survey modes used in the analyses in this paper.

Issues and Past Findings of Web-Mail Mixed-Mode Surveys

While some studies showed increased response rates in mixed-mode surveys (e.g., Quigley, Riemer, Cruzen, & Rosen, 2000), other studies (e.g., Dillman, Clark, & West, 1995) found that providing alternative response modes does not necessarily improve response rates. Furthermore, some studies even reported lower response rates of mixed-mode approach when compared with response rates from control groups that received only mail surveys (e.g., Griffin et al., 2001). In our meta-analysis here, however, it is not our purpose to compare mixed-mode surveys with surveys of one response mode. Instead, we focus on how options of alternative survey modes affect mode preferences of respondents and the overall response rate. First, we are interested in how different design conditions of Web-mail mixed-mode surveys affect respondents' preferences of survey mode (Web or mail). Second, we are interested in how different design conditions of Web-mail mixed-mode surveys affect the overall response rate of a Web-mail mixed-mode survey.

Mode preference has been examined in some mixed-mode survey studies, and the findings have been inconsistent. For example, Maier (2005) found 62% of responses through mail survey option, but Irani, Gregg, and Telg (2004) obtained 78% of responses through Web survey option. Percentage of responses through Web survey option in a Web-mail mixed-mode survey is an important indicator of the usefulness of including Web survey as an alternative survey mode. If very few respondents take advantage of the Web survey option, the usefulness of including the Web survey option would be limited in a mixed-mode survey. The same logic applies to the mail survey option when Web survey is initially offered. How respondents choose the response mode in a mixed-mode survey remains unclear. Zhang (2000) suggested that selection of survey response option might not merely depend on respondents' technological backgrounds or on their access to the Web, because some respondents who were experienced and frequent Internet users chose to reply via postal mail or fax. In the present study, design factors, such as option design, delivery format (i.e., in which format the surveys are initially provided to the respondents), mode delivery order (i.e., simultaneous mixed mode or sequential mixed mode), population type, incentive for survey response, and follow-up reminders, will be examined for being potential moderators for mode preferences in mixed-mode surveys.

In addition to the issue of mode preference, the overall response rate of a Web-mail mixed-mode survey is a more important concern in survey research in general; as a result, how some design factors of a mixed-mode survey may affect the overall response rate is of research interest. With these two major issues (i.e., mode preference and overall response rate in Web-mail mixed mode survey) in mind, we ask the following two research questions in this meta-analysis:

1. How do Web-mail mixed-mode survey design factors affect mode preferences of respondents?

2. How do Web-mail mixed-mode survey design factors affect overall response rates?

Methods

Source of Meta-Analytic Sample

Multiple databases were searched using the following key words either singly or in combinations: response rate, return rate, participation rate, Web, survey, questionnaire, postal, paper, mail, electronic, mixed-mode, option, and Internet. The databases used were Business & Company Resource Center, Business Index, Materials Business File (CSA), ERIC, Expanded Academic Index (ASAP), WebSM, Factivia, InfoTrac, Ingenta, PsycInfo, Pubmed, SCIRUS, Social Research Methodology, Social Science Abstract, ERIC, and Sociological Abstract. We also employed Google Web search engine in case there are any papers not in these databases. We stopped the literature search on November 5th, 2006, and any study published after this date is not included in this study. The most important criterion for inclusion in this meta-analysis sample was that, a study must have given respondents the options to respond to the in either mail or Web format.

Exclusion Criteria of Study Sample

Initially, we identified 566 articles spanning from 1996 to 2006. Of those 566 articles, 524 were excluded because they either did not use Web-mail mixed-mode surveys or did not report sufficient information (e.g., information on response rates). We tried to collect as many studies as possible, and all the studies included in this meta-analysis were Web-mail mixed-mode survey studies, in which respondents had the option to respond to the survey in either Web survey or mail survey format.

Excluded were studies that administered only mail surveys, only Web surveys, only e-mail surveys, disk-by-mail survey, Web banner surveys, and pop-up surveys, and those that solicited respondents on streets to fill out surveys, those that handed paper surveys to respondents in classrooms, those that administered Web and paper surveys at different times or to different populations (thus making survey populations in Web and mail survey modes less or not comparable), etc. Because the term "Internet-based survey" or "online survey" is often used in many articles, and may not actually mean Web-mail mixed-mode survey, we carefully examined each article, contacted authors when necessary, and only included those studies that gave respondents the option to fill out the same survey in either mail format (i.e. paper surveys sent and returned through mails, or surveys that can be printed out from e-mail notifications) or Web format (i.e., e-mail or mail notifications with links to Web surveys). We identified and included 42 studies that used Web-mail mixed-mode surveys. However, there were 53 study results for the meta-analysis because 8 studies had more than one sub-studies.

Table 1
Coding of Study Features

Variable name	Variable coding
Response rate of Web survey	A continuous variable (proportion)
Response rate of paper survey	A continuous variable (proportion)
Total sample size	A continuous variable
Option design	1 respondents had options for Web or mail survey modes
	2 mail survey respondents had no option for Web survey, but Web survey respondents had option for mail survey
	3 Web survey respondents had no option for mail survey, but mail survey respondents had option for Web survey
	4 non-respondents were provided with the other response option (e.g., non-respondents of mail survey mode were later provided with Web survey mode option, and vice versa)
Delivery format	1 mail survey respondents were sent mail notifications, and Web survey respondents were sent e-mail notifications
	2 all notifications were sent through mail
	3 all notifications were sent through e-mail
Mode delivery order	1 mode options were offered simultaneously
	2 Web survey options offered in reminders
	3 mail survey options offered in reminders
Population type	1 college population (e.g., students, academic member or faculty)
	2 professionals (journalists, managers, employees)
	3 association members and magazine subscribers
	4 institutions (companies and organizations)
	5 general populations and others
Incentive	1 no incentive provided
	2 some type of incentive provided
Follow-up reminders	0 no reminder
	1 one reminder
	2 two reminders
	3 three reminders
	5 five reminders
	8 eight reminders

Considering that a study result with a huge sample size could be given too much weight in analysis, we decided to eliminate one study from our statistical analyses. The sample size of this study was 2,272,973 (i.e. Haraldsen, Dale, Dalheim, & Strømme, 2002), which was almost five times of the total sample size of all the other 52 study results combined (i.e., n = 471,407). To avoid giving too much weight to this study in both random-effect model (i.e., forest plot analysis) and the fixed-effect model (general linear model), we decided to treat the study of Haraldsen et al. (2002) as an outlier, thus not including it in our statistical analyses. Not all studies reported both overall response rate and response rate difference between mail and Web surveys. As a result, the first research question examined mode preference based on 43 independent comparisons. The second research question examined the overall response rates based on the 52 study results. The survey topics of our collected studies covered a broad spectrum of disciplines, including education, business, psychology, social science, medicine, etc.

Coding of Study Features

The outcome variable of the first research question was the *response rate difference* between Web survey and mail survey modes. The outcome variable of the second research question was the *overall response rate* of a Web-mail mixed-mode survey. To understand what study features might have contributed to the inconsistent response rates in Web-mail mixed-mode survey studies, we recorded and coded six salient study features: (a) how potential respondents in a study were given the options to fill out Web or mail surveys, (b) in what format were surveys initially sent to respondents, (c) in what order were the options of survey modes given to respondents, (d) what type of population was involved, (e) whether incentive was provided, (f) how many follow-up reminders were sent to non-respondents. We considered these study features that might potentially affect survey response rates based on previous meta-analytic studies in the survey literature (e.g., Dillman, 2000; Heberlein & Baumgartner, 1978; Schonlau, Asch, & Du, 2003).

There had been a long history of mail surveys, and most people were familiar with this type of data collection method. Web surveys, however, required that respondents feel reasonably comfortable with the technology. This consideration led us to believe that different populations may react to Web survey mode differently, depending on their exposure to, and their comfort level with, Web technology. For this reason, we coded populations in these Web-mail mixed-mode survey studies into five groups (college population, professionals, association members, institutions, and general populations). Table 1 provides details about the coding of these six study features.

Data Analysis for Research Question #1
Response Rate Difference as Effect Size Measure in Random-Effect Model Analysis

Research question #1 is concerned about mode preference in Web-mail mixed-mode surveys as represented by the response rate difference between Web survey mode and mail survey mode. Response rate difference itself can be treated as the effect size measure, and it is not necessary to convert this variable into another form. In fact, any conversion of the variable would make it more difficult to understand. Throughout the study, we used "*RD*" to represent the outcome variable of interest, that is, the response rate difference between Web and mail modes in a mixed-mode survey study. This outcome variable was analyzed using a random effect model and the associated "forest plots" (e.g., DerSimonian & Laird, 1986). This response rate difference was computed as shown below:

$$RD = Risk\ Difference = (\text{Web mode response rate}) - (\text{mail mode response rate})$$

Thus, in a mixed-mode survey study involving Web and mail survey modes, a positive *RD* indicates a higher response rate from the Web survey mode than that of a mail survey mode, and a negative *RD* indicates the opposite. First, we conducted a pooled forest plot analysis for those 43 studies as an omnibus test for heterogeneity of the outcomes across the studies. Once the heterogeneity was confirmed statistically, we then followed up with stratified forest plot analyses as post-hoc tests to examine if there are statistically significant differences of different categories associated with each predictor (i.e., study feature).

Data Analysis for Research Question #2
Overall Response Rate as Effect Size Measure in a General Linear Model

In the second research question, the outcome variable is the overall response rate in the form of proportion. This outcome variable itself is a measure of effect size. The overall response rate is simply the sum of Web and mail survey mode response rates. Sample size typically plays an important role in the stability of a sample statistic: a larger sample size generally produces a more stable sample estimate. The accumulated effect size measure across the studies is a *weighted* effect size measure, and it gives more weight to an outcome from a large-sample study, and less weight to an outcome from a small-sample study. The weighting procedure based on sample size reduces the potential bias introduced by unstable estimates derived from small samples (Hunter & Schmidt, 1990; Rosenthal & Rubin, 1982; Yin & Fan, 2003).

The present study adopted such weighting procedure, and each effect size (i.e., the overall response rate of a mixed-mode survey) is weighted by using the following weight based on the study sample size and the cumulative sample size across the studies:

$$w_i = \frac{n_i}{\sum n_i}$$

where n_i is the sample size of a mixed-mode survey study result from which an overall response rate is obtained, and $\sum n_i$ is the sum of sample sizes across the 52 independent study results used for the second research question.

Results Research Question #1

Preliminary Descriptive Analysis

Table 2 presents the results of the preliminary descriptive analysis. Of those 43 results of response rate differences between Web and mail survey modes, the sample sizes varied considerably, with the smallest sample size being 162, the largest sample size being 166,433, and the average sample size being 10,781. Across those 43 comparison results, the unweighted average response rate of mail survey mode was higher than that of Web survey mode by 8% (27% for mail survey mode, and 19% for Web survey mode). Response rate differences also varied considerably. At one extreme, mail survey mode response rate was *higher* than Web survey mode response rate by 62% (Maier, 2005; n = 3,198). At the other extreme, mail survey mode response rate was *lower* than the Web survey mode response rate by 78% (Irani et al., 2004; n = 331). The standard deviation of the response rate differences was 0.32 (i.e., 32%), representing considerable variation in the response rate differences between Web and mail survey modes across those 43 study comparisons.

Table 2
Descriptive Statistics for Survey Mode Response Rates and Mode Preference

Variable	*M*	*SD*	Min	Max
Sample size	10781	33671	162	166433
Response rate				
Web survey	0.19	0.22	0.003	0.84
Paper survey	0.27	0.17	0.004	0.67
Response rate difference (*RD*)[a]	-0.08	0.32	-0.62	0.78

[a]*RD* = Web survey response rate - mail survey response rate

Analyses of Weighted Effect Size and the Effects of Study Features

Heterogeneity chi-square test (a pooled forest plot analysis). Figure 1 presents a pooled forest plot analysis using 463,563 respondents from 43 study results. There was a statistically significant heterogeneity in this pooled analysis (χ^2 (42, N = 43) = 34868.17, p < .001). In Figure 1, names on the left of the forest plot are first authors' names and publication years. Those studies are ordered by year of publications and author names. The effect of survey modes (Web vs. mail survey) on response rate is represented by "Risk Difference" (*RD*). The solid vertical line represents no effect of survey modes (*RD* = 0), i.e., there is no difference of response rates between mail and Web survey modes. Associated with each study, the black dot and the horizontal line represent a study's Risk Difference and its 95% confidence interval (95% CI). As discussed above, the response rate difference is used as the effect size measure of Risk Difference (*RD* = Web survey mode response rate - mail survey mode response rate). Those studies with higher Web survey mode response rates than mail survey mode response rates fall on the right side of the "no effect" vertical line, and the studies with lower Web survey mode response rates than mail survey mode response rates fall on the left side of the "no effect" vertical line. If a study has a confidence interval (the short horizontal line) that covers the "no effect" vertical line, it suggests that response rate difference between Web and mail survey modes is statistically non-significant.

The overall mode effect of response rate difference between Web and mail survey modes is represented by the dashed vertical line. The dashed vertical line represents the combined mode effect (-0.14). Because the dashed vertical line is on the left of the "no effect" solid line, it indicates a lower response rate in the Web survey mode than in the mail survey mode. More specifically, the Risk Difference of -0.14 for the overall mode effect suggests a 14% lower of response rate in Web survey mode than in mail survey mode. It does not touch the "no effect" line, suggesting that the response rate difference found between Web and mail survey modes was statistically significant.

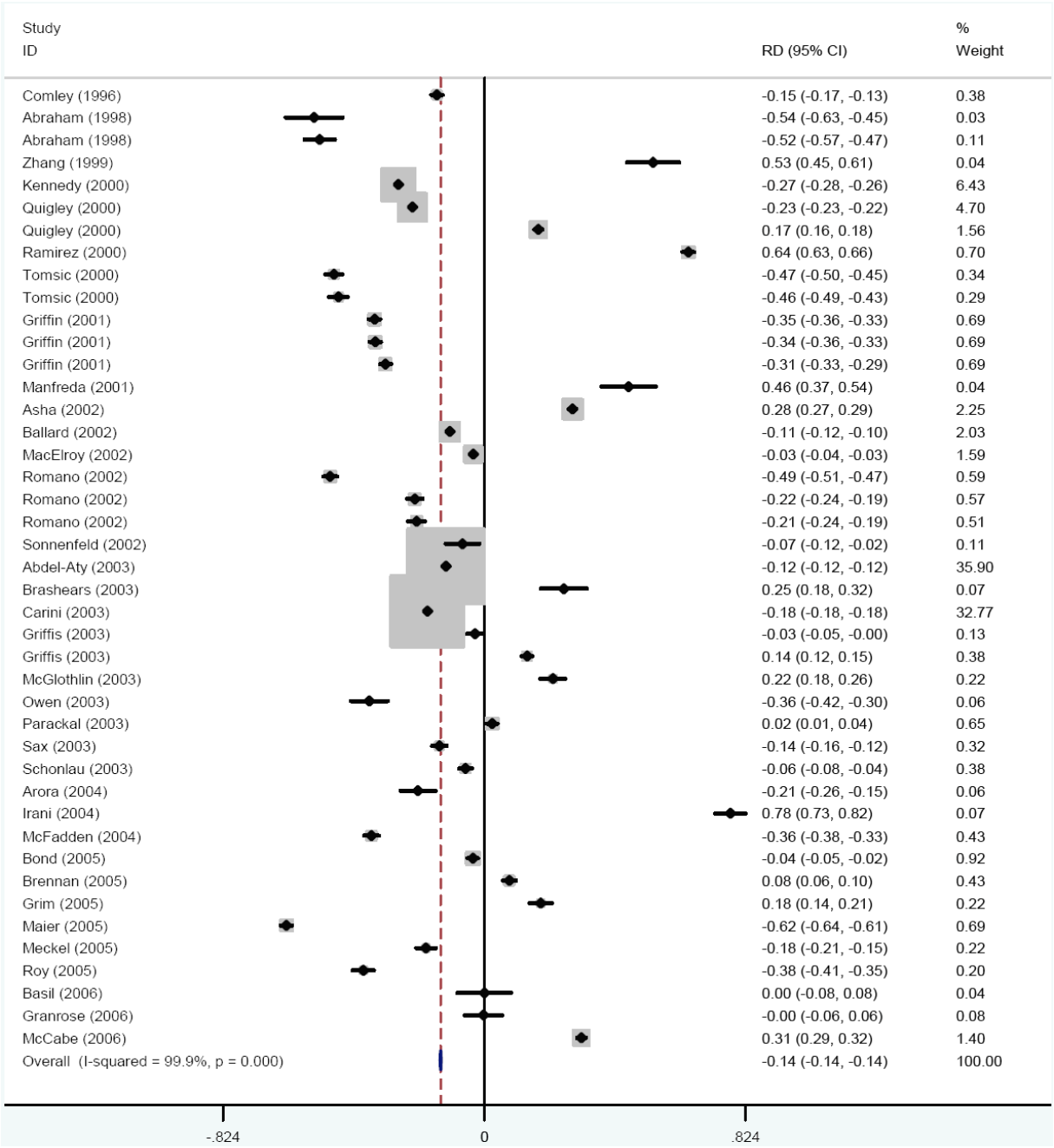

Figure 1. *Pooled Forest Plot Analysis for Mode Preference*

Once we had the statistical evidence for the heterogeneity of the results across the studies (i.e., the overall omnibus test associated with Figure 1), we conducted forest plot analyses for each study feature to see which of the study features might have contributed to such heterogeneity of study outcomes. The details of these stratified forest plot analyses are noted below.

A forest plot analysis stratified by "Option Design". For the eight studies in which all respondents had options for either Web or mail survey, the response rate difference is statistically non-existent (*RD* = -0.01; 95% CI = -0.02 to 0.00). In some sense, this condition may be called *true* mixed-mode survey, because both response options were provided to all potential respondents. From those studies in which mail survey respondents did not have the option of Web survey mode, the mode preference was 29% in favor of Web surveys (RD = 0.29; 95% CI = 0.28 to 0.30). Such a preference was also found in the study excluded for its extraordinarily large sample size (Haraldsen et al., 2002). In those studies in which Web survey respondents had no option for mail survey response mode, the response rate difference was 16% in favor of mail surveys (*RD* = -0.16). These findings are counter-intuitive, and in later "Discussion", we will look at these seemingly counter-intuitive results. From those studies in which non-respondents of one survey mode (e.g., mail survey mode) were provided the other response option (i.e., Web survey mode) in the follow-up reminder, the response rate difference was 19% in favor of Web

surveys (*RD* = 0.19; 95% CI = 0.18 to 0.20). In addition, the four levels of this study feature variable are all statistically different in terms of their respective mode preference, as shown by their statistically non-overlapping confidence intervals of mode preference (i.e., "Subtotal" for each of the four levels) in the forest plot presented in Appendix 1. The confidence intervals for the mode preference for each level are extremely narrow, due to the fact that the mode preference was weighted by the large sample sizes of the studies in the random effect model analysis.

A forest plot analysis stratified by "Delivery Format". In the studies in which mail survey respondents were sent mail notifications and Web survey respondents were sent e-mail notifications, the response rate difference favored mail survey mode by 3 % (*RD* = -0.03; 95% CI = -0.04 to -0.02). In those studies in which all surveys were sent in mail format, the mode preference was 16% in favor of mail survey modes (*RD* = -0.16; 95% CI = -0.16 to -0.15). In those studies in which all surveys were sent in e-mail format, the mode preference was 36% in favor of Web survey modes (*RD* = 0.36; 95% CI = 0.35 to 0.37). The three levels of *Delivery Format* all have statistically different mode preference measures, as shown by their statistically non-overlapping confidence intervals of mode preference (i.e., "Subtotal" for each of the three levels) in the forest plot for *Delivery Format*.

A forest plot analysis stratified by "Mode Delivery Order". From those mixed-mode survey studies that delivered Web and mail response options at the same time, the mode preference was 15% in favor of mail survey modes (*RD* = -0.15). In those studies in which respondents were sent mail surveys first and offered the Web survey option in the follow-up reminders, the node preference was 23% in favor of mail survey mode (*RD* = -0.23; 95% CI = -0.24 to -0.23). In those mixed-mode surveys in which the respondents were sent Web surveys first and then offered mail survey option in the follow-up reminders, the mode preference was 24% in favor of Web survey modes (*RD* = 0.24; 95% CI = 0.23 to 0.24). The three levels of *Mode Delivery Order* are statistically different in terms of their respective mode preference, as shown by their statistically non-overlapping confidence intervals of mode preference (i.e., "Subtotal" for each of the three levels) in the forest plot presented in Appendix 1.

A forest plot analysis stratified by "Population Type". In those mixed-mode surveys that sampled from populations of association members and magazine subscribers, mode preference was statistically non-significant (i.e. *RD* = 0; 95% CI = -0.00 to 0.01). Surprisingly, in the mixed-mode surveys involving college populations, there was the mode preference of 18% in favor of mail surveys (*RD* = -0.18), although college populations have long been considered as the most technology-savvy population (Couper, 2000). From those mixed-mode surveys involving institutions, mode preference was as high as 44% in favor of mail surveys (*RD* = -0.44; 95% CI = -0.46 to -0.43). The five levels of *Population Type* are statistically different in terms of their respective mode preference, as shown by their statistically non-overlapping confidence intervals of mode preference (i.e., "Subtotal" for each of the five levels) in the forest plot presented in Appendix 1.

A forest plot analysis stratified by "Incentive". In those studies that did not use any incentive, the response rate difference favored the mail survey mode by 16% (*RD* = -0.16). In the studies that used some form of incentive, Web survey response rate was still lower than mail survey response rate by 10% (*RD* = -0.10; 95% CI = -0.11 to -0.10). The two levels of *Incentive* use are statistically different in terms of their respective mode preference, as shown by their statistically non-overlapping confidence intervals of mode preference (i.e., "Subtotal" for each of the two levels) in the forest plot presented in Appendix 1.

A forest plot analysis stratified by "Follow-up Reminders". In the studies that did not use any follow-up reminder, or used one to three reminders, mode preference favored the mail survey mode by 15%, 10%, 13%, and 31%, respectively. But in the studies that used five or eight reminders (only one study using eight reminders), the mode preference favored Web survey mode. There appears to be little consistency here. Here, some results were based on very small numbers of studies (e.g., there was only one study with eight follow-up reminders); as a result, we should not make too much out of these results. The five levels of *Follow-up Reminders* are statistically different in terms of their respective mode preference, as shown by their statistically non-overlapping confidence intervals of mode preference (i.e., "Subtotal" for each of the five levels) in the forest plot presented in Appendix 1.

Ideally, interaction among the moderators could be potentially interesting and informative. For example, we may be interested in knowing if *Option Design* statistically interacts with *Population Types* (i.e., if the effects of different levels of *Option Design* are consistent across different *Population Types*). However, to explore all potential interactions among the six study feature variables would require too many independent variables, and this would not be statistically viable for our sample size of 43. As a result, such interaction analysis would result in very small cell sample size conditions (e.g., only one or two study results in many combinations) that would render statistical analysis meaningless or impossible. Because of these considerations, we did not pursue interaction analysis among the moderator variables.

Results Research Question #2

Preliminary Descriptive Analysis

Table 3 presents the results of the preliminary descriptive analysis. Of those 52 overall response rates, their sample sizes varied considerably, with the smallest sample size being 162, and the largest sample size being 166,433. The average sample size was 9,066. Across these 52 independent results, the unweighted overall response rate of Web-mail mixed-mode surveys was 46% on average. Overall response rates also varied considerably. At one extreme, the overall response rate is 10% (Griffis, Goldsby, & Cooper, 2003; sample size = 585). At the other extreme, the overall response rate is 90% (Irani et al., 2004; sample size = 331). The standard deviation of the overall response rate was 0.21, representing considerable variation in overall response rates across these 52 study results.

Table 3
Descriptive Statistics for Overall Response Rate as the Outcome Variable

Variable	*M*	*SD*	Min	Max
Sample size	9066	30790	162	166433
Overall response rate[a]	.46	0.21	.10	.90

[a]The overall response rate of a Web-mail mixed-mode survey

Analyses of Weighted Effect Size and the Effects of Study Features

Table 4 presents results of our fixed-effect general linear model for the second research question. We examined if the six study features were associated with the variation of the effect sizes (i.e., overall response rates) across the studies by using a fixed-effect general linear model analysis. The dependent variable was the weighted overall response rate of Web-mail mixed-mode surveys, and the independent variables were those six study features described previously. This weighted general linear model analysis revealed that 82% of variation (R^2 = .82) in the weighted effect sizes was associated with those six study features.

We partitioned the variation in the overall response rate across the studies into unique proportions (i.e., η^2 = Type III sum of squares / total sum of squares) associated with each of the six study features. Variance partitioning relies on Type III sum of squares (i.e., the unique proportion of variance in the outcome variable that is associated with a factor, given that all other factors are already in the general linear model). Because the six study feature variables are statistically correlated (i.e., collinearity among the six independent variables), such partitioning (i.e., η^2) could *underestimate* each independent variable's statistical association with the outcome variable. With this consideration in mind, we see that the η^2s of the six study feature variables range from 0.03 to 0.11, and all have statistically significant contributions to the variation of the overall response rates across the studies. Overall, when no study feature was considered, the overall response rate of Web-mail mixed-mode surveys was 28% for weighted average and 46% for unweighted average. Here, the considerable difference between the weighted and the unweighted averages was caused by a significant correlation between sample size and overall response rate (r = -.254, $p < .05$), indicating that studies with smaller sample sizes having higher response rates than those with larger sample sizes. It is possible that studies with smaller sample sizes could be more focused in taking care of mixed-mode survey administrations, while studies with large sample sizes could be less focused, thus resulting in lower response rates. Detailed results for these study features are described below (in the ranking order of η^2 for each study feature).

Population Types. Under this study feature, in the Web-mail mixed-mode surveys involving college populations, the overall response rate was 34% on the average, while the mixed-mode surveys involving "general population" had the lowest response rate (15%), and those involving "association members and magazine subscribers" had the highest (51%).

Option Design. The mixed-mode survey response rates varied considerably across the conditions under this study feature, ranging from 52% (those studies where mail survey respondents had no option for Web survey, but Web survey respondents had option for mail survey) to 27% (in those mixed-mode surveys where Web survey respondents had no option for mail survey, but mail survey respondents had option for Web survey). For the mixed-mode surveys where non-respondents of one survey mode were provided the other response mode option in follow-up reminders, the average overall response rate was 46%.

Table 4
The Overall Response Rate of Web-Mail Mixed-Mode Surveys (o) and Effects of Study Features

Study features	η^2 [I]	n [II]	Weighted response rate analysis Weighted $\bar{o}$	Unweighted $\bar{o}$	Σn_i [III]
Overall		52	.28	.46	471407
Option design	.06*				
1 respondents had options for Web or mail survey		8	.29	.38	8057
2 mail survey respondents had no option for Web survey, but Web survey respondents had option for mail survey		5	.52	.59	11306
3 Web survey respondents had no option for mail survey, but mail survey respondents had option for Web survey		32	.27	.43	439440
4 non-respondents of one survey mode were provided the other response mode option in follow-up reminders		7	.46	.57	12604
Delivery format	.04*				
1 mail survey respondents were sent mail notifications, and Web survey respondents were sent e-mail notifications		11	.43	.56	40308
2 all notifications were sent through mail		36	.27	.43	424427
3 all notifications were sent through e-mail		5	.57	.46	6672
Mode delivery order	.04*				
1 mode options were offered simultaneously		33	.25	.44	381347
2 Web survey options offered in reminders		7	.42	.48	59039
3 mail survey options offered in reminders		12	.47	.51	31021
Population type	.11**				
1 college population		13	.34	.44	201044
2 professionals (journalists, managers, employees)		12	.40	.52	44858
3 association members and magazine subscribers		11	.51	.47	26127
4 institutions (companies and organizations)		8	.58	.52	7199
5 general populations and others		8	.15	.30	192179
Incentive	.03*				
1 no incentive		38	.37	.47	275226
2 some incentive		14	.17	.41	196181
Follow-up reminders	.03*				
0 no reminder		13	.25	.42	384996
1 one reminder		8	.47	.51	41246
2 two reminders		16	.31	.33	28286
3 three reminders		11	.51	.55	9374
5 five reminders		3	.52	.65	7174
8 eight reminders		1	.90	.90	331

[I]Proportion of variance in o (i.e., overall response rate) associated with this study feature; [II]Number of effect sizes involved; [III]Cumulative sample size across the studies grouped under each study characteristic.
*$p < .05$. **$p < .01$.

Mode Delivery Order. The study feature had statistically significant effect on the variation of overall response rate across the mixed-mode survey studies. From those studies that offered respondents options for either Web and mail surveys simultaneously, the overall response rate was 25%. In those studies where respondents were sent mail surveys first and offered the option for Web survey mode in follow-up reminders, the overall response rate was 42%. In those where respondents were sent Web surveys first and then offered the option for mail survey mode in follow-up reminders, the overall response rate was 47%.

Delivery Format. The study feature showed a statistically significant effect on the variation of overall response rate across these mixed-mode survey studies. From those in which mail survey respondents were sent mail notifications and Web survey respondents were sent e-mail notifications, the overall response rate was 43%. In those where all notifications were sent through mail, the overall response rate was 27%. In those studies where all notifications were sent through e-mail, the overall response rate was 57%.

Incentive. The study feature was shown to be statistically associated with the overall response rates across the mixed-mode survey studies. However, the direction of such association is contrary to our general expectation that incentive would increase response rate. In the studies that did not use any incentive, the overall response rate was 37%, but in those that used some form of incentive, the overall response rate was 17%. We will discuss this counter-intuitive finding later in "Discussion".

Follow-up Reminders. In general, f*ollow-up reminders* appears to be positively related to the mixed-mode survey response rate: 25% for the mixed-mode surveys with no reminder, 47% for those with one reminder, 31% for those with two reminders, 51% for those with three reminders, 52% for those with five reminders, and 90% for one study with eight reminders. However, some results here were based on relatively small number of studies (e.g., only one study with eight follow-up reminders), and caution is warranted in interpreting these findings.

Discussion

Survey response rate is an important consideration, as low response rate has the potential of introducing non-response bias, thus resulting in misleading information about the issues covered in a survey. As Internet use becomes more prevalent, more researchers use Web-mail mixed-mode survey design in order to increase response rates. Descriptive findings in this meta-analysis showed that, in the studies involving Web-mail mixed-mode surveys, there was considerable variation in mode preference (i.e., the response rate differences between mail and Web survey modes), and there was also considerable variation in the overall response rates of the mixed-mode surveys. We used random-effect model analysis (forest plot analysis) to examine mode preferences, and used fixed-effect general linear model to examine what study features contributed to the overall response rate of the mixed-mode surveys.

For the issue of mode preference in mixed-mode surveys, we observed a preference of mail survey mode over Web survey mode, with mail survey mode response rate being 14% higher than Web survey mode response rate (see Figure 1) in general. However, in the mixed-mode surveys where respondents were offered both response options (i.e., Web or mail survey response modes) at the same time, there was *no* statistically significant difference between mail and Web survey response rates. Our analyses also showed that, for non-respondents of one survey mode (e.g., non-respondents of mail survey mode), it might be useful to provide a different survey mode (i.e., Web survey mode) in the follow-up.

The stratified forest plot analysis results for *Option Design* may appear counterintuitive. In the mixed-mode surveys where Web survey respondents had no option for mail survey, but mail survey respondents had the option for Web survey, shouldn't we get a higher response rate of Web surveys? Why did we get a lower response rate for Web surveys? It turns out that this counter-intuitive finding is the result of confounding by another study feature of *Delivery Format*. Among the five mixed-mode survey studies coded "2" in *Option Design* (i.e. mail survey respondents had no option for Web survey, but Web survey respondents had option for mail survey), the relationship between *Delivery Format* and response rate difference was not clear, possibly due to a small sample size. However, among the 27 studies coded "3" in *Option Design* (i.e. Web survey respondents had no option for mail survey, but mail survey respondents had option for Web survey), 25 studies offered mail survey first and offered Web survey option in follow-up reminders. It makes sense that if mail survey option was provided first and Web survey option was only offered in the reminders, the majority of respondents should have already taken the mail survey before the Web survey option became available in the reminders, thus resulting in more mail survey mode responses than Web survey responses.

The findings of this study appear to be in line with the discussion by Zhang (2000) that the selection of response medium (e.g., Web or mail) might not merely depend on respondents' technological backgrounds or on their

access to the Web. In addition, the present study also suggests that survey researchers may need further research to enhance our understanding about the relative strengths of alternative response modes (Dillman, 2000) in using mixed-mode strategy.

For the question of overall response rates from Web-mail mixed mode surveys, results of the weighted general linear model analysis showed that all six study features had statistically significant contributions to the variability of the overall response rates of the mixed-mode surveys, with the study feature *Population Types* having the largest unique contribution. We did not see a consistent pattern between mode preference (Research Question #1) and overall response rates (Research Question #2), and a higher response rate could be obtained when respondents showed preference for either Web or mail survey modes.

Some counter-intuitive findings related to the study feature of *Option Design* could be explained by the confounding of *Mode Delivery Order* (i.e., if the respondents were given the options simultaneously or sequentially). When all notifications (for both mail and Web survey response options) were sent in mail format, the overall response rate was lower than when the notifications were sent in e-mail format. This finding appeared to be in line with some previous studies (e.g. Reips & Franek, 2004): if the URL for the Web survey has to be typed in by hand from a mailed invitation, this might have some negative effect on the overall response rate.
Both the use of incentives and the use of follow-up reminders accounted for statistically significant proportion of the variations in the overall response rates of the mixed-mode surveys. In general, the more reminders were used, the higher response rates were observed. However, because of small number of studies under some conditions (e.g., only one study with eight follow-up reminders), caution is warranted in this interpretation.

Contrary to a general belief that use incentive can increase survey response rates, the studies examined in this study did not show this. However, we would not want to make a strong statement about this finding, because alternative interpretation for this finding might be possible. For example, there might have been inherent differences between the studies that used incentives and those that did not (such as length, topic, or sponsor, populations, etc.), and these differences may be confounded with the effect of incentive use. Researchers who expect more 'difficult' surveys might have chosen to use incentives more often than researchers dealing with 'easy' surveys; and it is possible that the response rates of the former would be even lower if they did not use any incentives. Without controlling for such differences, it would be difficult to say anything definitive about the effect of incentive use. Not specifically dealing with mixed-mode survey design, Göritz (2006) provided a general summary about the effect of incentives on response rates. For example, material incentives increase Web survey response rates, and promised nonmonetary incentives seem to work better in online than in offline survey studies. In the current meta-analysis, only a very limited number of the studies used some types of incentives, thus making it impossible for us to examine the impact of different incentives on response rates. The findings do suggest a need for future studies of incentive uses in mixed-mode surveys.

Limitations

Like many other studies, our study here has its limitations. The most obvious limitation is that, the analyses related to some study features (e.g. *Option Design*, *Incentive*) are very likely to be confounded by other coded or unknown study features such that some findings may appear counter-intuitive, or the analysis results could be difficult to interpret. We discussed some of these difficulties in our “Discussion”. The confounding effect of coded features could potentially be disentangled by analyzing the interaction effect among the study features, but such analysis would require a larger number of studies so that the sample size (i.e., the number of studies) in the cells of interaction terms would be adequate. In the present study, we were not able to analytically deal with such potential confounding effects, because the relatively small number of studies would make it statistically impossible to analyze all the main effect and interaction terms. This leaves some potentially interesting and informative questions unanswered. With the accumulation of more mixed-mode survey studies in the literature in the future, such analysis may be possible as time goes by.

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[1] Experiments taken into account in the meta-analyses are designated by an asterisk.

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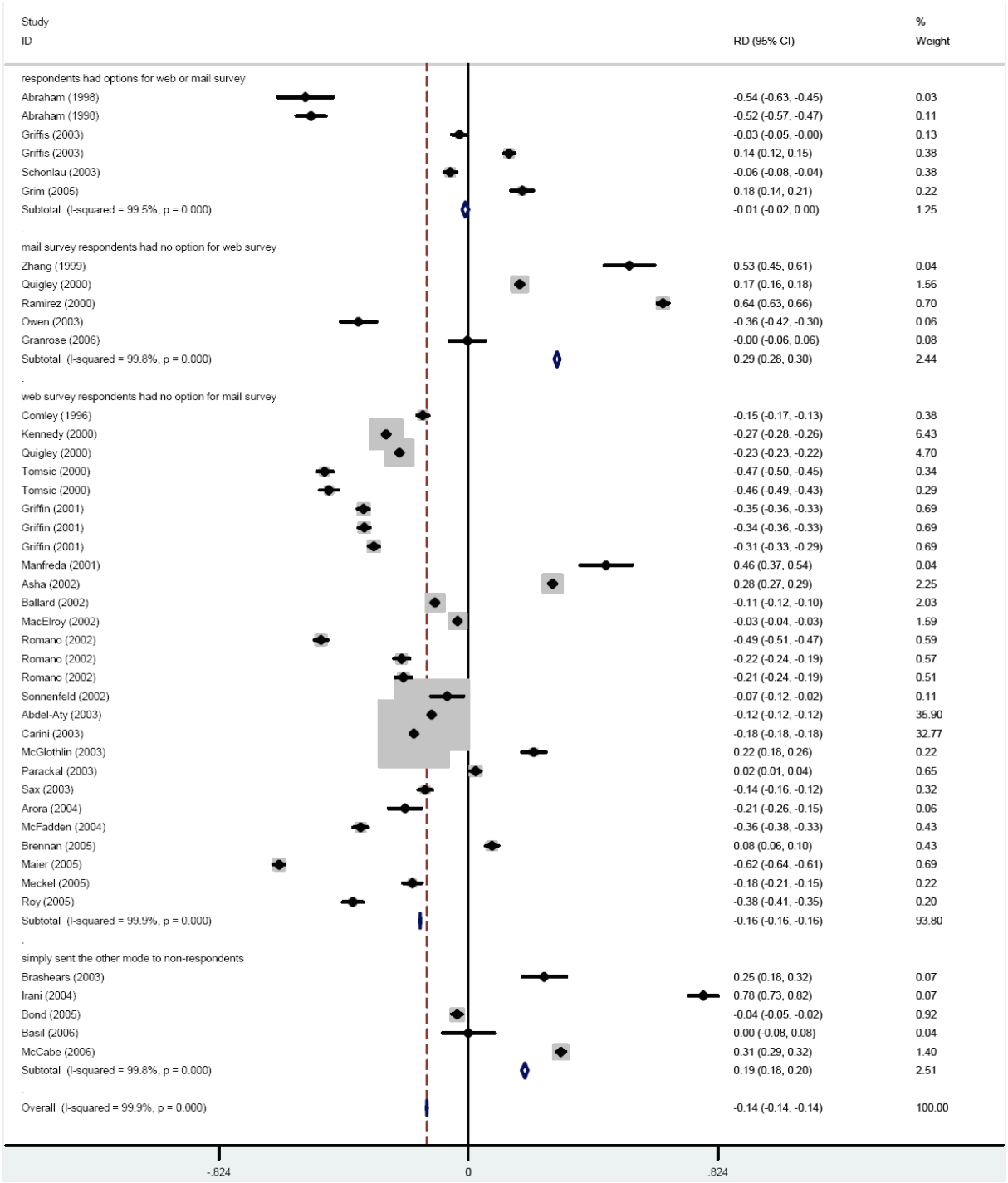
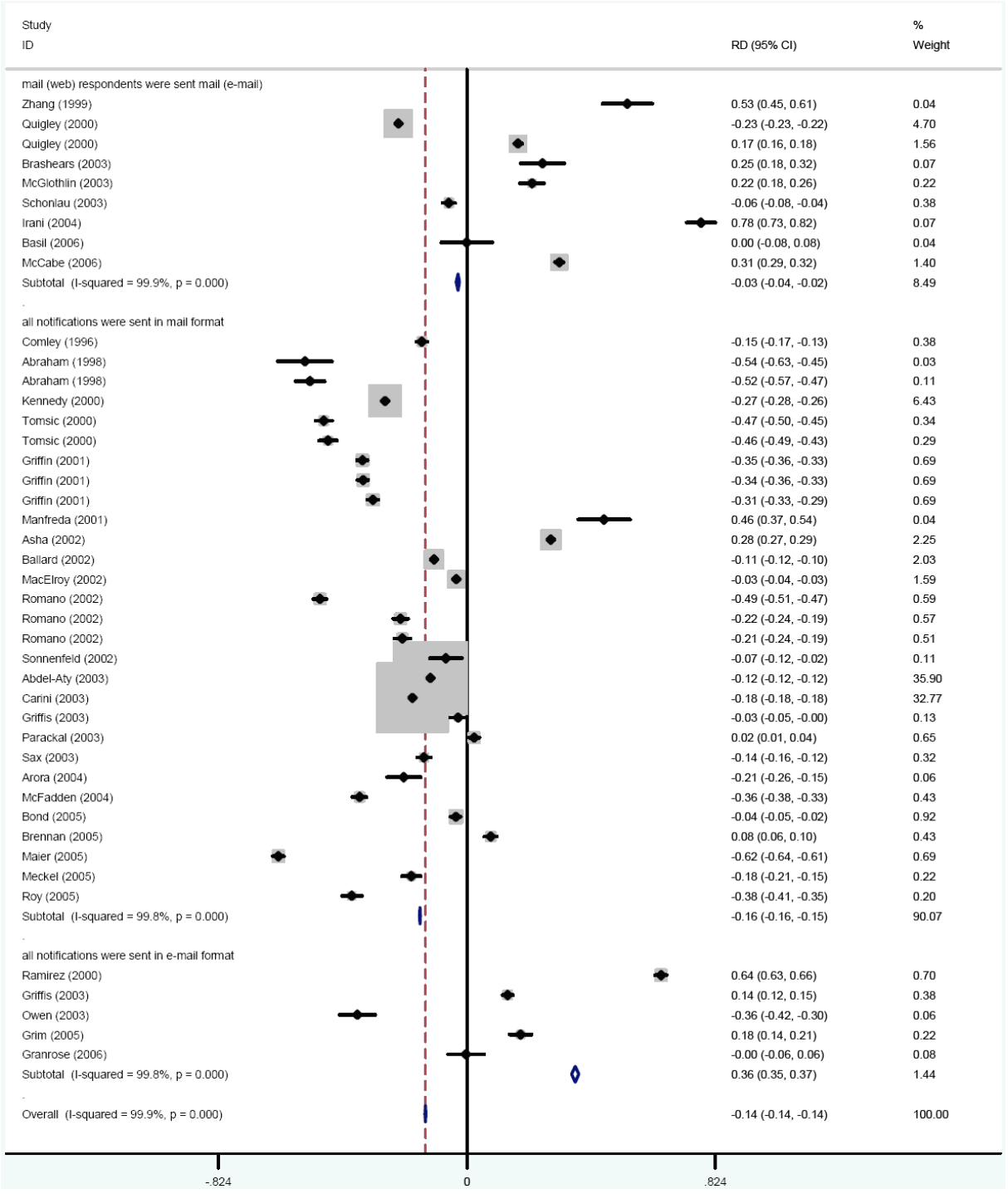
Appendix 1: Stratified Forest Plots

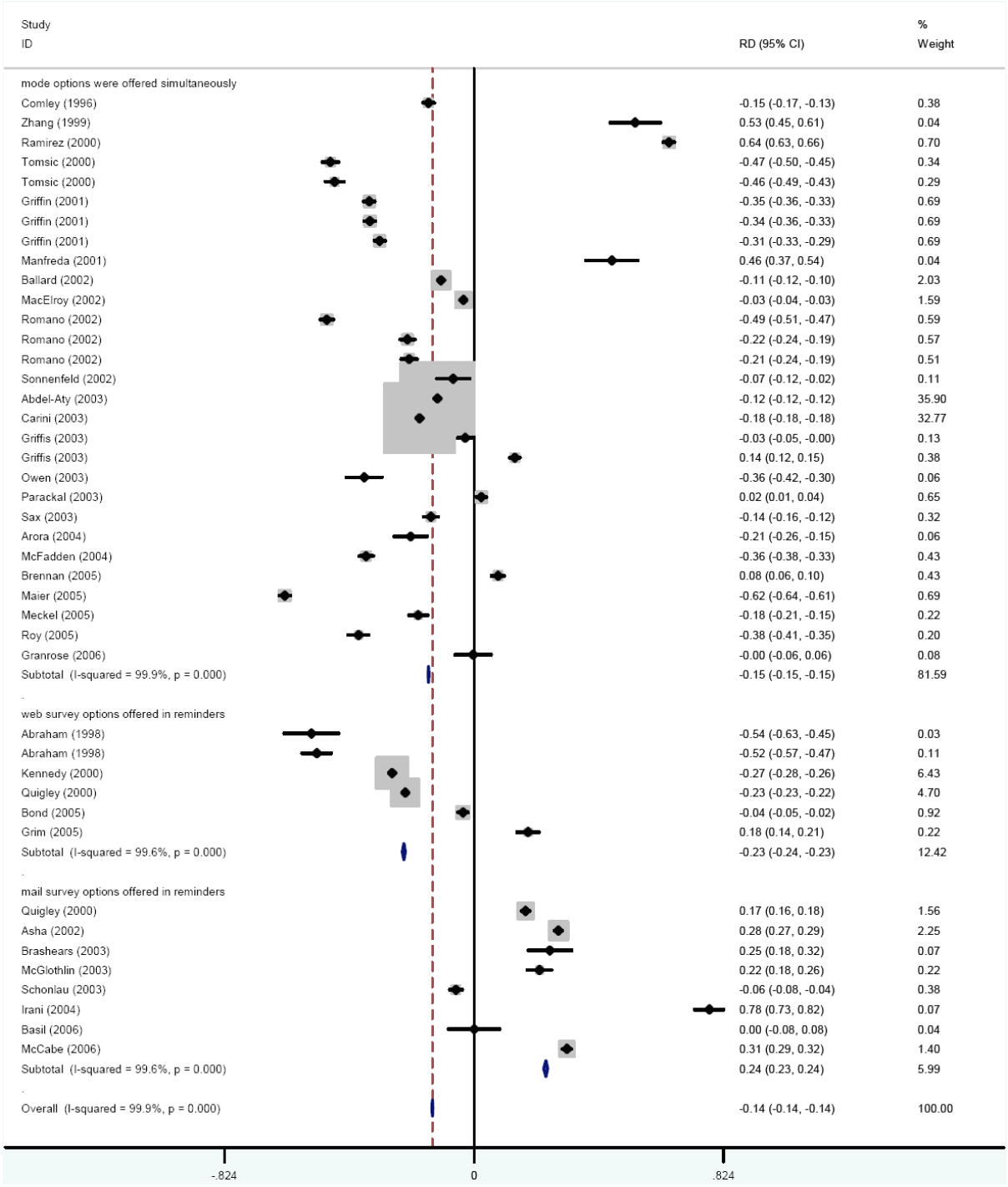
A Forest Plot Stratified by "Option Design"



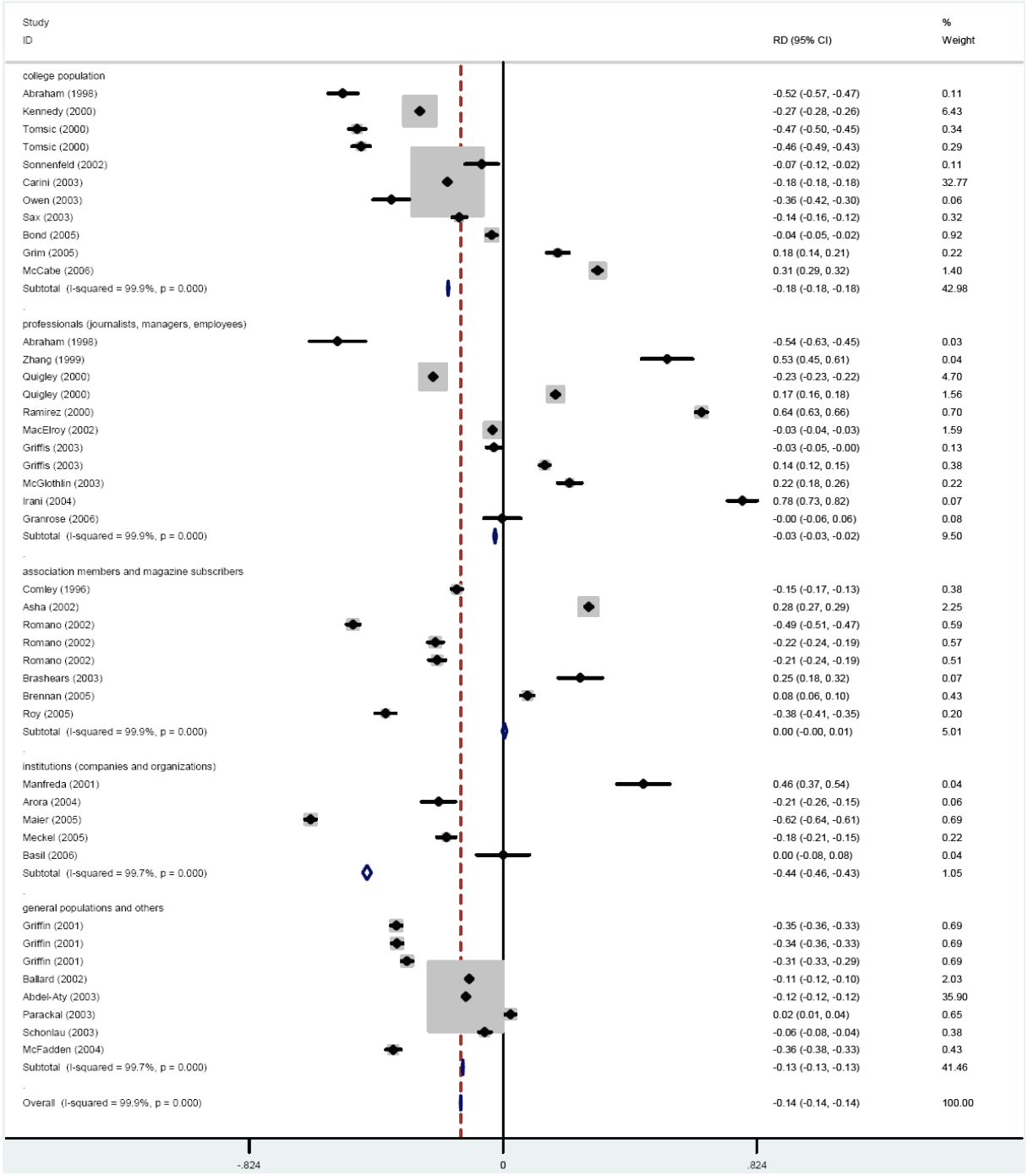
A Forest Plot Stratified by "Delivery Format"



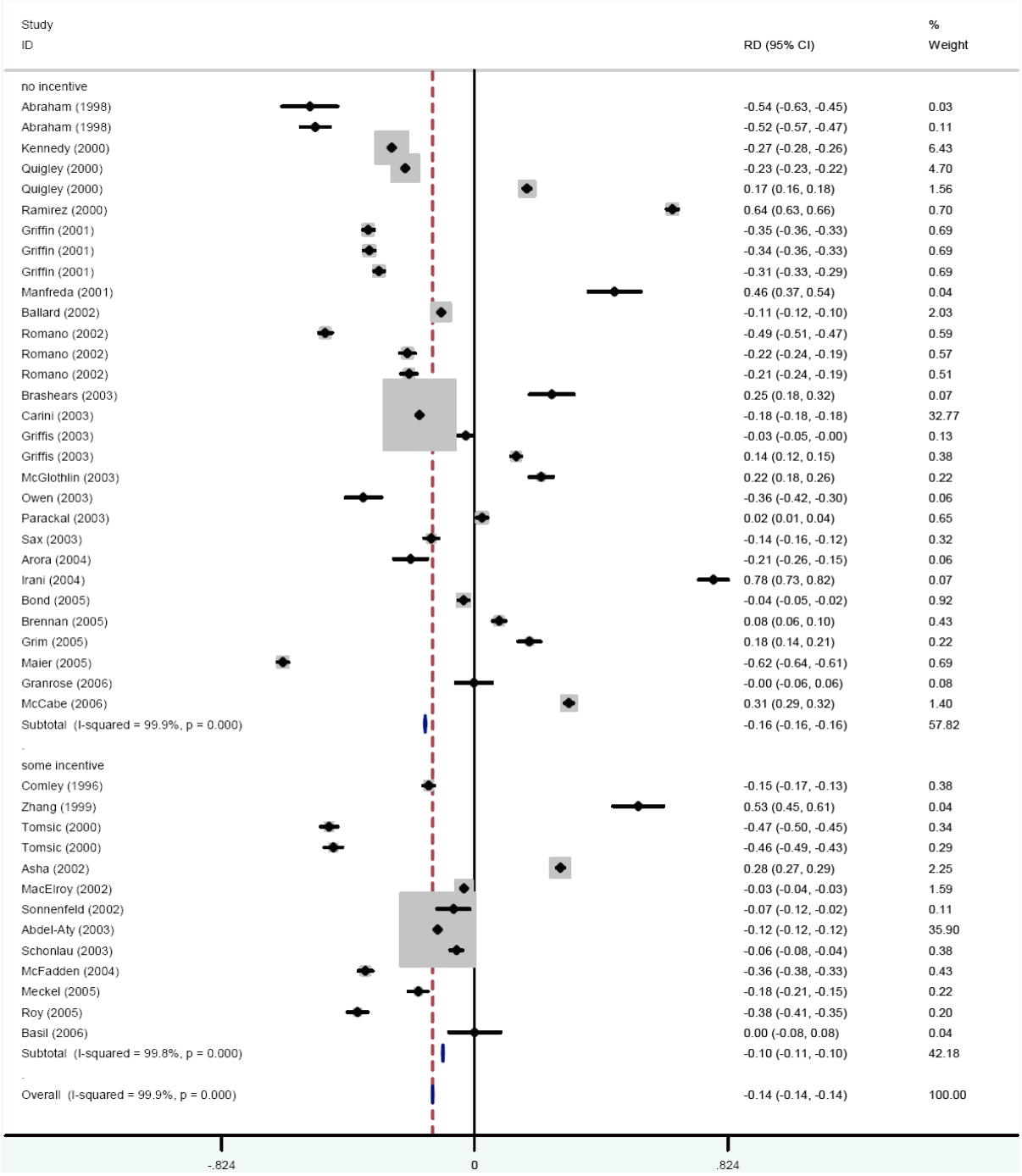
A Forest Plot Stratified by "Mode Delivery Order"



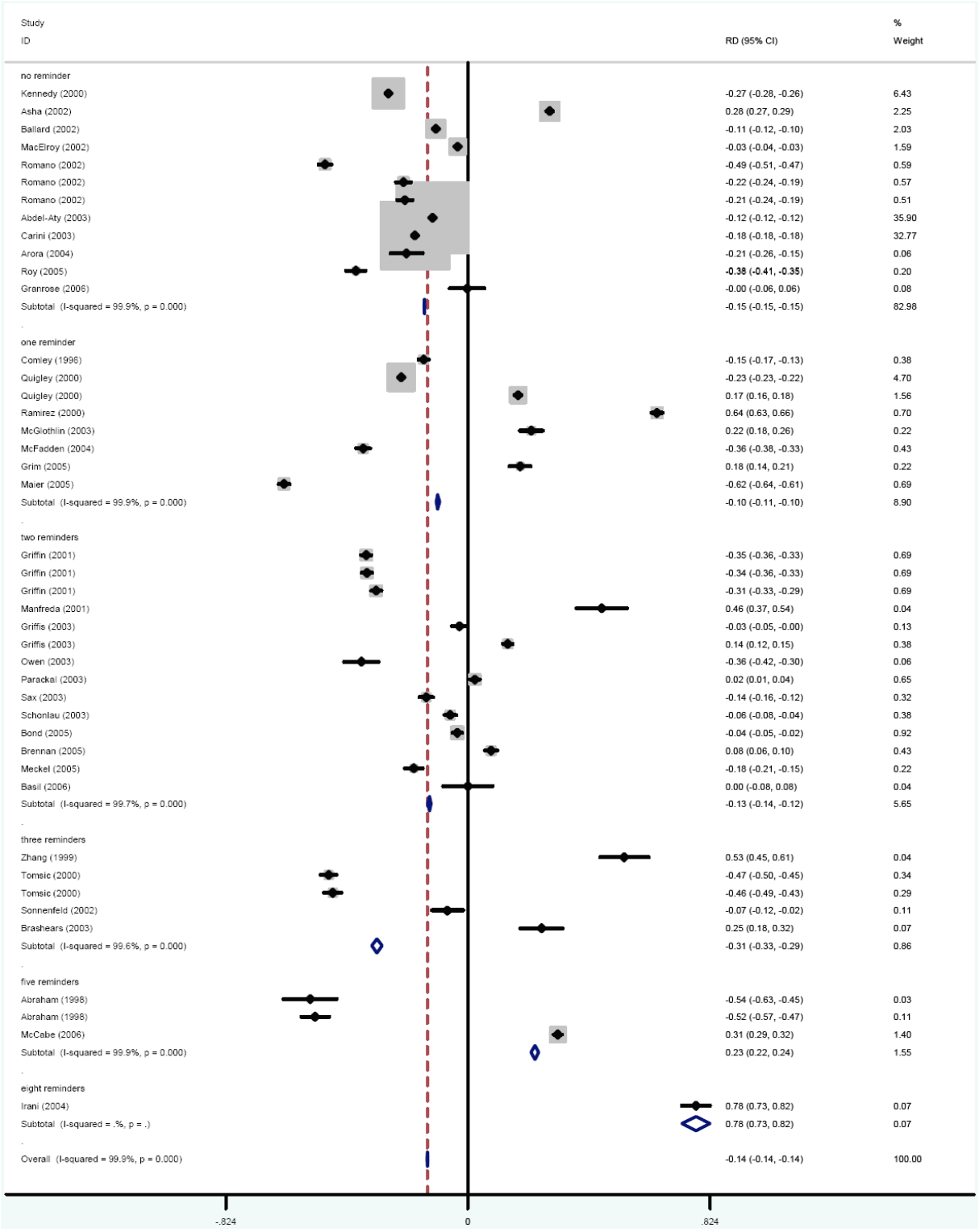
A Forest Plot Stratified by "Population Type"



A Forest Plot Stratified by "Incentive"



A Forest Plot Stratified by "Follow-Up Reminders"



Appendix 2

Studies Used in the Meta-Analysis

Study	Study sample size	Paper survey response rate	Web survey response rate	Overall response rate
Comley (1996)	1,769	16%	1%	17%
Abraham (1998)	162	67%	14%	81%
Abraham (1998)	512	58%	6%	64%
Zhang (1999)	201	18%	71%	89%
Kennedy (2000)	29,809	35%	8%	43%
Quigley (2000)	7,209	10%	27%	37%
Quigley (2000)	21,805	32%	10%	42%
Ramirez (2000)	3,243	11%	76%	87%
Tomsic (2000)	1,591	52%	4%	56%
Tomsic (2000)	1,360	51%	5%	57%
Griffin (2001)	3,189	36%	2%	38%
Griffin (2001)	3,205	37%	2%	40%
Griffin (2001)	3,202	33%	2%	35%
Manfreda (2001)	200	18%	63%	81%
Sax (2001)	1,468	–	–	24%
Asha (2002)	10,447	14%	42%	56%
Ballard (2002)	9,400	18%	8%	26%
Bourgaux (2002)	1,547	–	–	52%
Bourgaux (2002)	599	–	–	57%
Bourgaux (2002)	187	–	–	52%
MacElroy (2002)	7,362	10%	7%	17%
Romano (2002)	2,368	44%	23%	67%
Romano (2002)	2,631	43%	22%	65%
Romano (2002)	2,739	57%	8%	64%
Sonnenfeld (2002)	490	27%	20%	46%
Abdel-Aty (2003)	166,433	12%	0.3%	13%
Brashears (2003)	323	24%	49%	72%
Carini (2003)	151,910	25%	7%	32%
Griffis (2003)	1,776	0.4%	14%	14%
Griffis (2003)	585	6%	4%	10%
Ketsche (2003)	637	–	–	43%
McGlothlin (2003)	1,022	21%	42%	63%
Owen (2003)	295	39%	2%	41%
Parackal (2003)	3,000	11%	13%	24%
Sax (2003)	1,496	19%	5%	24%
Schonlau (2003)	1,750	13%	7%	20%
Arora (2004)	268	24%	3%	26%
Irani (2004)	331	6%	84%	90%
McFadden (2004)	2,000	40%	4%	45%
Porter (2004)	1,138	–	–	36%
Porter (2004)	1,134	–	–	33%
Bond (2005)	4,283	19%	16%	35%
Brennan (2005)	2,000	9%	17%	25%
Grim (2005)	1,000	14%	32%	45%
Keith (2005)	804	–	–	59%
Maier (2005)	3,198	67%	5%	72%

Studies Used in the Meta-Analysis (continued)

Study	Study sample size	Paper survey response rate	Web survey response rate	Overall response rate
Meckel (2005)	1,000	24%	6%	30%
Roy (2005)	941	40%	2%	43%
Arbuagh (2006)	330	–	–	58%
Basil (2006)	200	25%	25%	49%
Granrose (2006)	358	20%	20%	41%
McCabe (2006)	6,500	10%	40%	50%

Note. 1. The multiple entries of Abraham (1998), Quigley (2000), Tomsic (2000), Griffin (2001), Bourgaux (2002), Romano (2002), Griffis (2003), and Maio (2004) represent multiple independent results in the same study; 2. Raw effect size (mode preference) in the 1st research question = Web survey response rate - mail survey response rate; 3. Raw effect size (overall response rate) in the 2nd research question = the overall response rate of a Web-mail mixed-mode survey.
–: information not available from the study.