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Long-term impact of pregnancy on mortality and graft outcomes in kidney transplant recipients: a systematic review and meta-analysis

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Abstract

Background and aim: Pregnancy in kidney transplant recipients involves complex physiological changes that could potentially impact long-term graft function and survival. Despite some evidence suggesting minimal long-term effects on graft survival, conflicting results on graft function and timing-related risks highlight the need for a comprehensive review. This systematic review and meta-analysis aim to evaluate the long-term impact of pregnancy on patient survival, graft failure, serum creatinine levels, estimated glomerular filtration rate (eGFR), and proteinuria in kidney transplant recipients.

Materials and methods: We conducted a systematic review and meta-analysis adhering to PRISMA guidelines and registered with PROSPERO (CRD42024569702). We searched PubMed, Scopus, Web of Science, Cochrane Library, and Ovid MEDLINE. Studies were eligible if they provided data on adult kidney transplant recipients (>18 years) who became pregnant post-transplant and included a control group of non-pregnant or non-conceived individuals.

Results: Among the 6,118 results screened, 19 studies met the eligibility criteria and were included in the meta-analysis. The risk of allograft failure or graft loss was similar between pregnant and non-pregnant controls (OR 1.13, 95% CI: 0.83–1.53, p = 0.43), with a slightly higher adverse outcome rate in pregnant patients (25.4% vs. 19.8%). All-cause mortality risk was also comparable (OR 0.63, 95% CI: 0.38–1.07, p = 0.09), with low heterogeneity (I^2 = 12%). Creatinine levels were significantly lower before pregnancy compared to after delivery (SMD -0.33, 95% CI: -0.52 to -0.14, p = 0.0008).

Conclusion: Pregnancy in kidney transplant recipients leads to increased creatinine levels in postpartum but does not significantly affect long-term graft survival. While creatinine levels generally decrease during pregnancy, they show variability by trimester. The risk of allograft failure and mortality is similar between pregnant and non-pregnant recipients, though adverse outcomes are slightly more frequent in pregnant patients, emphasizing the need for careful monitoring and individualized management.

INTRODUCTION

The physiological hemodynamic and hormonal changes during pregnancy and postpartum, such as altered kidney blood flow, glomerular filtration rate, weight gain, and conditions associated with pregnancy including preeclampsia, gestational hypertension, gestational diabetes prompt questions about their potential long-term effects on maintenance and function of allografts in kidney transplant recipients. In this context, several studies found that undergoing pregnancy or having a live birth does not negatively impact the long-term survival of kidney allografts or patient survival among kidney transplants (1, 2). Although pregnancy in kidney transplant recipients accelerates the decline in eGFR, it does not significantly increase the risk of graft failure, death-censored graft failure, or a 50% reduction in eGFR (3). However, various factors encountered during pregnancy including drug-treated hypertension are associated with poorer postpregnancy graft survival and a trend toward increased serum creatinine levels in patients with higher prepregnancy serum creatinine (2). Conversely, some studies report conflicting results, indicating that pregnancy in kidney or kidney-pancreas transplant recipients frequently leads to a decline in graft function, with nearly half of the patients experiencing significant deterioration during pregnancy (4). The specific risk factors contributing to the adverse post-pregnancy deterioration of graft function remain to be fully identified and understood.

The timing of pregnancy warrants further attention, as it could potentially influence graft outcomes as shown by previous evidence. Pregnancy within the first year after kidney transplantation is associated with a higher risk of both acute and death-censored graft loss (6). This elevated risk of death-censored graft loss persists into the second year following the transplant. However, the risk does not significantly increase in the third-year post-transplant (6).

Previous systematic reviews and meta-analyses have predominantly focused on pregnancy and neonatal outcomes rather than allograft outcomes and function (7, 8). A previous meta-analysis showed that while pregnancy in kidney transplant recipients has a minimal impact on long-term graft survival, it may lead to a slight increase in serum creatinine levels within 2 years postpartum. Long-term graft function remains stable, with no significant differences in graft loss when comparing pregnant recipients to nulliparous controls (9). While a significant proportion of kidney transplant recipients are women of childbearing age, with pregnancy rates in this group typically ranging from 10–30% (10), addressing this issue is essential to ensure equitable representation of pregnant individuals in transplant medicine. To better understand the risks and implications for women with kidney transplants, there is still a need for a comprehensive meta-analysis that integrates and synthesizes the latest data on kidney graft health with the inclusion of appropriate control kidney transplant recipients who did not conceive after kidney transplant. Therefore, in this systematic review and meta-analysis, we aimed to evaluate the long-term impact of pregnancy on patient survival, graft failure and serum creatinine levels in kidney transplant recipients to inform clinical practice and guide preconception counseling.

MATERIALS AND METHODS

The protocol of this study was registered with PROSPERO (CRD42024569702). The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement was used to report this systematic review and meta-analysis (11).

Search strategy and study selection

We systematically searched multiple databases including PubMed, Scopus, Web of Science, Cochrane Library, and Ovid MEDLINE, targeting studies published in peer-reviewed journals up to August 24, 2024. Our search terms encompassed a combination of pregnancy-related keywords, kidney transplantation-related keywords, and keywords related to specific outcomes including mortality, graft outcomes, serum creatinine and eGFR change, and proteinuria. Further information on the search methodology and the keywords employed can be found in Supplementary Table S1. The articles were imported into the EndNote 21 and duplicates were excluded automatically and subsequently re-checked automatically upon uploading to Covidence and through manually by the authors during the screening process (LO, SMAR, SU, MG). Three different authors (LO, SMAR, SU) independently screened the title and abstract of each identified article for adherence to predetermined inclusion and exclusion criteria. Each article is screened by at least two authors. The selection of articles for the study was based on consensus among the authors, with any discrepancies discussed with a fourth author (MG). Subsequently, each full-text article found eligible in the screening process underwent a triple-blind review by the authors (LO, SMAR, SU). Any discrepancies regarding the eligibility of full-text articles were discussed with the fourth author (MG). During full-text screening, the references in the full-text articles are reviewed to identify additional eligible articles. The study screening and selection process is outlined in Fig. 1.

Selection criteria

Studies that provide data on adult kidney transplant recipients (> 18 years) who have become pregnant after undergoing kidney transplantation, with a non-pregnant or non-conceived control group, are of interest. Included studies must meet the following criteria: 1) they involve adult kidney transplant recipients who have become pregnant post-transplant; 2) they include a control group of previously non-pregnant individuals; 3) they report outcomes of interest such as patient mortality, graft survival, serum creatinine levels, estimated glomerular filtration rate changes, and proteinuria. Studies were excluded if they did not report on long-term prognostic outcomes of post-transplant pregnancy, focusing instead only on immediate or early postpartum outcomes (e.g., those reporting data no later than 8 weeks or only during pregnancy); if they included only kidney transplant patients who became pregnant without a non-pregnant or non-conceived control group; if they did not provide the outcomes of interest; or if they were animal studies, reviews, editorials, letters, commentaries. Additionally, studies that are not available in full text or for which no English translation is available were also excluded.

Quality Assessment

The assessment of study quality was conducted utilizing the Newcastle-Ottawa scale (NOS), which assigns a maximum total score of nine points, with a score of seven or higher indicative of high quality, a score between four to six indicating moderate quality, and a score of three or lower indicates poor quality. Quality assessment of the studies is performed by three separate authors (LO, SMAR, SU) the results are compared and consensus has been made (Supplementary Table S2 and S3).

RESULTS

We conducted a comprehensive search across the specified databases, initially retrieving a total of 6118 studies. After removing duplicate publications, 5795 studies remained for screening based on titles and abstracts, and 289 of those underwent further full-text assessment for eligibility. Following the evaluation of predefined inclusion and exclusion criteria, 19 studies were ultimately selected for inclusion in the present meta-analysis (Fig. 1, Table 1).

Table 1
Summary of included studies

Study	Study Type	Participant characteristics	Outcome measures	Key findings	Quality assessment
First et al (1995) (5)	Case-Control	44 women of reproductive age who had kidney transplantation between 1967 and 1990 ● 18 women with posttransplant pregnancies ● 26 paired nonpregnant controls 23 male controls	● Graft survival ● Serum creatinine changes ● Patient mortality	Pregnancy provokes transient improvement in serum creatinine levels, which return to baseline after pregnancy No adverse long-term effect on patient survival or graft function/survival	High (Score: 8)
Fischer et al (2005) (13)	Case-control	162 women of reproductive age who had kidney transplantation ● 81 women with posttransplant pregnancies ● 81 paired nonpregnant controls	● Patient mortality ● Graft survival ● Serum creatinine	Pregnancies in renal recipients do not negatively affect long-term patient and graft survival or graft function, independent of the immunosuppressive regimen.	High (Score: 8)
Gorgulu et al (2010) (15)	Case-Control	57 women of reproductive age who had kidney transplantation ● 19 patients with posttransplant pregnancies ● 38 paired nonpregnant controls	● Serum creatinine ● Graft survival ● Patient mortality	Graft outcomes such as serum creatinine level and acute rejection episodes or graft survival did not differ significantly between the groups.	High (Score: 8)
Gutiérrez et al (2009) (27)	Case-Control	54 women of reproductive age who had kidney transplantation ● 27 women with posttransplant pregnancies ● 27 paired nonpregnant controls	● Graft survival ● Serum creatinine ● Patient mortality	There were no acute rejection episodes or graft losses during pregnancy and puerperium. Renal function at the end of pregnancy was lower among the pregnant compared to the control group.	High (Score: 8)

Study	Study Type	Participant characteristics	Outcome measures	Key findings	Quality assessment
				At 1 and 10 years, renal function was similar among the groups; pregnancy did not have a significant effect on graft function.	
Kaatz et al (2023) (28)	Case-Control	80 women of reproductive age who had single kidney or combined kidney-pancreas transplantation ● 40 women with posttransplant pregnancies ● 40 paired nonpregnant controls	● eGFR/serum creatinine changes ● Proteinuria ● Graft survival ● Patient mortality	● Pregnancies after transplantation showed good maternal and allograft outcomes. ● Pre-pregnancy factors, except for a declining renal allograft function in the year before pregnancy, were not helpful in predicting the outcomes.	High (Score: 8)
Kashanizadeh et al (2007) (19)	Retrospective Cohort	86 female kidney transplant recipients with at least one posttransplant pregnancy and 125 kidney transplant recipients with no pregnancy matched for age, cause of end-stage renal disease (ESRD), treatment protocol, and first creatinine (Cr) between 1996 and 2002	● Graft survival ● Patient survival ● Serum creatinine	Two (3.3%) patients in group I and 2 (1.6%) patients in group II died during the follow-up. Eight (9.2%) patients in group 1 and 9 (7.2%) in group II lost their allografts. The five-year patient graft survival rates were not significantly different between the study groups. Only 10.6% of the pregnant group had elevated serum creatinine levels while at the same time, 28% of the nonpregnant group had elevated serum creatinine levels. There was no correlation between the number of pregnancies and creatinine levels.	High (Score: 8)
Kim et al (2008) (16)	Case-Control	48 women who conceived after undergoing renal transplantation and 187 transplanted	● Graft survival ● Serum creatinine	The graft failure rate from transplantation to the end of follow-up did not differ	High (Score: 8)

Study	Study Type	Participant characteristics	Outcome measures	Key findings	Quality assessment
		non-pregnant controls matched according to age at transplantation, immunosuppressive regimen, and time of transplantation between 1991 and 2005		between the pregnant and nonpregnant groups. The 10- and 15-year graft survival rates were 78.5% and 67.3%, respectively, in the pregnant group, and 75.0% and 58.1%, respectively, in the control group. The 10-year graft survival rates were also similar in the 11 women who became pregnant less than or equal to 12 months after transplantation and 37 who became pregnant more than 12 months after transplantation. Serum creatinine levels did not differ significantly between the groups at the end of the follow-up period.	
Levidiotis et al (2009) (1)	Retrospective Cohort	120 parous women matched with 120 nulliparous women by year of transplantation, duration of transplant, age at transplantation 5 year, and pre delivery creatinine for parous women or serum creatinine for nulliparous women	● Graft survival ● Patient survival	Five-year unadjusted graft survival rates for patients and control subjects were 89% and 85.3%, respectively; 10-year rates were 66.4% and 74.8%, respectively; and 15-year rates were 56.5% and 55.7, respectively. Unadjusted patient survival rates censored for graft failure for patients and control subjects at 5 year were 99.2% and 95.2%, respectively; 10-yr patient survival rates were	High (Score: 8)

Study	Study Type	Participant characteristics	Outcome measures	Key findings	Quality assessment
				94.0% and 91.7%, respectively; and 15-yr survival rates were 89.6% and 86.8%, respectively. First live birth was not associated with a poorer 20-year graft or patient survival.	
Pour-Reza-Gholi et al (2005) (29)	Retrospective Cohort	Retrospective data on 74 pregnancies in 60 patients were reviewed and completed through phone interviews were compared with information on a control group of female kidney recipients.	● Graft survival ● Serum creatinine	One-, 3-, 5-, and 10-year graft survival was 100%, 96.5%, 94.5%, and 77.1% in the pregnant group versus 93.2%, 85.7%, 81%, and 64.7% in the control group, respectively. Chronic graft dysfunction and graft loss were seen in 24 and 18 cases of the pregnant group and in 17 and 17 cases of the control group, respectively. The last creatinine level was not significantly different in the pregnant versus the control group.	High (Score: 8)
Radaelli et al (2023) (20)	Case-Control	78 pregnant women (cases), with a total of 97 gestations and a matched control group of 78 female KT patients	● Graft survival ● Patient survival ● Serum creatinine ● Proteinuria	Graft survival was higher in cases than in controls in 5 years (85.6% vs 71.5%, p = 0.012) and 10 years (71.9% vs 55.0%, p = 0.012) of follow-up. Patient survival was also higher in cases than controls in 5 years (98.6% vs 85.8%, p = 0.004) and 10 years (95.2% vs 80.3%, p = 0.004) of follow-up. Median creatinine before conception	High (Score: 8)

Study	Study Type	Participant characteristics	Outcome measures	Key findings	Quality assessment
				and one year after did not differ (1.2 vs. 1.2 mg/dL). Median UPCR before pregnancy and one year after did not differ (0.3 vs. 0.29).	
Rahamimov et al (2006) (21)	Case-Control	39 women became pregnant after renal transplantation and 177 women did not become pregnant after renal transplantation. These controls were matched to the pregnant group based on 12 factors known to affect graft survival.	● Graft survival ● Graft function	The survival rates for grafts (61.6%) and patients (84.8%) from transplantation to the end of a 15-year follow-up in women who conceived after transplantation were comparable to those of the 177 women in the matched control group, who had survival rates of 68.7% and 78.8%, respectively. Additionally, there were no significant differences in long-term graft function between the two groups.	High (Score: 9)
Salmela et al (1993) (30)	Case-Control	66 women of reproductive age who had kidney transplantation ● 22 women with posttransplant pregnancies ● 44 paired nonpregnant controls 39 male transplant patients who became fathers posttransplant	● Graft survival ● Patient mortality ● Serum creatinine changes	Pregnancy accelerated the deterioration of graft function, and long-term graft survival is significantly worse in patients with posttransplant pregnancies	High (Score: 8)
Sibanda et al (2007) (2)	Retrospective Cohort	193 pregnancies were reported in 176 kidney transplant recipients, considering 17 of the women were multiparous.	• Graft survival • Patient mortality • Serum creatinine changes	Pregnancy after kidney transplantation was associated with a favorable outcome for both the mother and the fetus. In the absence of poor prepregnancy renal	High (Score: 8)

Study	Study Type	Participant characteristics	Outcome measures	Key findings	Quality assessment
				function and existence of an hypertensive state, the long term graft survival remained optimal.	
Stoumpos et al (2016) (31)	Case-control	Obstetric and kidney transplant outcomes who have been pregnant between 1973 and 2013 have been analyzed. Additionally, a case-cohort study with 138 pregnancies, 89 of them being renal transplant recipients have been analyzed.	• Graft survival • Patient mortality • Serum creatinine changes • eGFR	Pregnancy did not adversely affect long-term graft survival or overall patient outcomes, albeit high rates of obstetric complication. Serum creatinine changes and eGFR remained stable.	High (Score: 9)
Sturgiss et al (1995) (18)	Case-control	36 kidney allograft recipients. 18 of these became pregnant and rest of the nulliparous population was assigned as the control.	• Graft survival • Patient mortality • Serum creatinine changes	Pregnancy in kidney transplant recipients did not negatively impact long-term graft function or patient survival. Serum creatinine levels remained stable even after 15-years post-transplant follow-up.	High (Score: 8)
Svetitsky et al (2018) (32)	Retrospective Cohort	A total of 22 pregnancies that resulted in live births were observed in 18 women who underwent kidney or combined kidney-pancreas transplants	• Graft survival • Serum creatinine changes • eGFR, • proteinuria	Pregnancy following kidney or simultaneous kidney-pancreas transplantation did not significantly affect long-term graft function (serum creatinine, eGFR) or increase proteinuria compared to controls, but comprehensive follow-up is recommended.	High (Score: 8)

Creatinine values before pregnancy and after delivery were reported in seven studies (12–18). Kidney transplant patients had significantly lower creatinine values before pregnancy compared to the post-delivery follow-up period, with a standardized mean difference (SMD) of -0.33 (95% CI: -0.52 to -0.14, p = 0.0008). The heterogeneity across the studies was low (I^2 = 18%). In a sensitivity analysis, excluding the study by Fischer et al. (13) eliminated the heterogeneity entirely, while still maintaining the statistical significance of the effect (p = 0.03) (Fig. 2).

We also compared creatinine values throughout the entire pregnancy duration to the initial baseline values. Five studies provided data on creatinine levels before pregnancy and during the first trimester in kidney transplant patients (13–17). In the pooled analysis, creatinine levels tended to decrease during the first trimester; however, this effect did not reach statistical significance (SMD 0.88, 95% CI: -0.40 to 2.17, p = 0.18). The results were limited by high heterogeneity (I^2 = 97%) (Fig. 3). After excluding the study by Fischer et al. (13) creatinine levels were found to be higher in the pre-conception period compared to the first trimester (SMD 0.25, 95% CI: 0.02 to 0.48, p = 0.04), with low heterogeneity (I^2 = 0%). These results should be interpreted with caution, as the significant variation in heterogeneity before and after the exclusion of Fischer et al. (13) suggests that the findings may be sensitive to specific studies and may not be fully generalizable.

Conversely, creatinine values before pregnancy were significantly higher compared to those reported in the second trimester (SMD 0.22, 95% CI: 0.01 to 0.43, p = 0.04), with low heterogeneity across studies (Fig. 4) (12, 14–17). These findings align with the expectation that creatinine levels tend to decline as pregnancy progresses, contrasting with the anticipated rise following delivery.

Although creatinine levels tended to increase in the last trimester, the effect was not statistically significant (SMD − 0.51, 95% CI: -1.36 to 0.34, p = 0.24) (Fig. 5) (13–17). Excluding the study Fischer et al. (13) from the analysis eliminated heterogeneity, but the creatinine levels remained similar during the both time-frames.

Creatinine values were comparable between the first and second trimesters (SMD 0.02, 95% CI: -0.21 to 0.26, p = 0.84) (Fig. 6) (14–17). However, the comparison between the first and third trimesters was influenced by substantial heterogeneity. In the pooled analysis, the heterogeneity was high, and the effect did not reach statistical significance (p = 0.11) (Fig. 7). Notably, after excluding the study by Fischer et al. (13) creatinine values were significantly lower in the first trimester compared to the third trimester (SMD − 0.30, 95% CI: -0.30 to -0.06, p = 0.01).

Data concerning the risk of allograft failure or graft loss was comparable between pregnant patients and non-pregnant controls (OR 1.13, 95% CI: 0.83–1.53, p = 0.43) (Fig. 8). However, the incidence of adverse kidney outcomes was slightly higher in pregnant patients (25.4% vs. 19.8%).

Similarly, the risk of all-cause mortality was similar in pregnant and non-pregnant KT patients (OR 0.63, 95% CI: 0.38–1.07, p = 0.09), with low heterogeneity across studies (I^2 = 12%) (Fig. 9) (1, 5, 13, 18–21). The publication bias was displayed as a funnel plot, in case of studies investigating graft loss (Fig. 10).

DISCUSSION

This systematic review and meta-analysis including 19 studies found that the risk of allograft failure or graft loss was similar between pregnant and non-pregnant controls, although there was a slightly higher rate of adverse outcomes in pregnant patients. The risk of all-cause mortality was similar between the two groups in our study. While acute rejection rates in pregnant kidney transplant recipients are relatively low and similar across various regions (ranging from 3–8%) in the literature, the impact of pregnancy on long-term graft survival in previous studies was less clear (8). In this regard, a previous meta-analysis showed that the overall graft loss rates at 1, 2, and 5 years after pregnancy are not significantly different from those in non-pregnant recipients (8). Some studies suggest that pregnancy does not adversely affect graft survival and may even have favorable outcomes in certain cases. However, these findings could be influenced by selection bias, as those who become

pregnant after a kidney transplant are often younger, and healthier, which may skew the results. Another meta-analysis on this subject found that while the incidence of graft loss increases over time postpartum—9.4% within 2 years, rising to 38.5% after more than 10 years—pregnancy generally does not have a significant long-term impact on graft function, with stable serum creatinine levels observed beyond 2 years (9), as in line with our findings. Notably, there was a marginally higher serum creatinine increase of 0.18 mg/dL within 2 years postpartum (9). Key risk factors for adverse outcomes included preconceptional hypertension, proteinuria, and high pre-pregnancy serum creatinine levels, but the type of delivery and immunosuppressive regime did not significantly affect graft survival (9).

Pregnant kidney transplant patients generally face low risks of maternal death and worsening kidney function if their initial kidney function is normal, though these risks increase with pre-existing kidney impairment (22, 23). The research, involving 92 pregnancies in 67 women from 1972 to 2019, found that pre-pregnancy kidney function significantly affects both pregnancy and graft outcomes (24). Women with a higher pre-pregnancy eGFR (≥ 50 mL/min/1.73m²) had better pregnancy outcomes and longer post-pregnancy graft survival compared to those with lower pre-pregnancy eGFR (< 50 mL/min/1.73m²) (24). Conversely, pregnancies in women with lower pre-pregnancy eGFR were associated with greater declines in kidney function and higher rates of maternal and fetal complications (24). Nevertheless, the full clinical picture of the alterations in serum creatinine in the trimesters and post-pregnancy varies between the studies. A study evaluating 34 pregnancies in kidney transplant recipients found that graft dysfunction, defined as an increase in serum creatinine at least 0.3 mg/, occurred in 15 cases, primarily due to preeclampsia, rejection, or infections (25). Despite these issues, most graft dysfunctions were temporary, with no significant long-term difference in graft function before and after pregnancy, though graft rejection remained a significant risk for graft loss (25). In another study, pregnancy outcomes in women who had undergone kidney transplantation found that although 78.9% of pregnancies resulted in live births, there was a high rate of preterm birth (56.5%) and hypertensive disorders (76%) (26). Therefore, prematurity, low birth rates, and intrauterine growth retardation were among the adverse neonatal outcomes in this group (23). Prepregnancy serum creatinine levels were indicative of risk; higher levels were associated with increased rates of pre-eclampsia and poorer graft function post-pregnancy, with one-third of women experiencing graft deterioration during pregnancy, and 63.2% of those with worsening graft function did not return to baseline within two years postpartum (26). Overall, the importance of pregnancy-associated conditions cannot be underestimated when evaluating kidney function. In our study, creatinine levels were significantly lower before pregnancy compared to after delivery. During pregnancy, creatinine levels did not change significantly in the first trimester but were higher before pregnancy than in the second trimester. There was an observed increase in creatinine from pre-conception to the first trimester when one study was excluded. Creatinine levels did not significantly change between the first and third trimesters.

Conclusion

Overall, given the high prevalence of pregnancy among women of childbearing age who are kidney transplant recipients, it is crucial to thoroughly address the potential concerns related to maternal, fetal, and allograft outcomes. Several studies have previously shown an increased rate of pregnancy-related complications in kidney transplant recipients. However, the allograft outcomes and patient mortality seemed to be unaffected in most of the studies, as in our meta-analysis. Despite these findings, it is important to consider limitations such as publication bias and the evolution of transplant management practices over time. Our study encompasses

research spanning several decades, which may introduce variability in treatment protocols and patient management, potentially influencing the results. Additionally, applying these findings broadly to specific high-risk populations, such as individuals with already low GFR or other pre-existing risk factors, may be misleading. It is crucial to recognize that these groups might experience different outcomes, and the generalized results may not fully capture their unique risks and needs. Future research should investigate both the specific risk factors or obstetric complications affecting graft and patient outcomes in pregnant kidney transplant recipients, the impact of transplant-related management strategies on these outcomes, and the allograft prognosis of pregnancy with reduced kidney function.

Declarations

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Figures

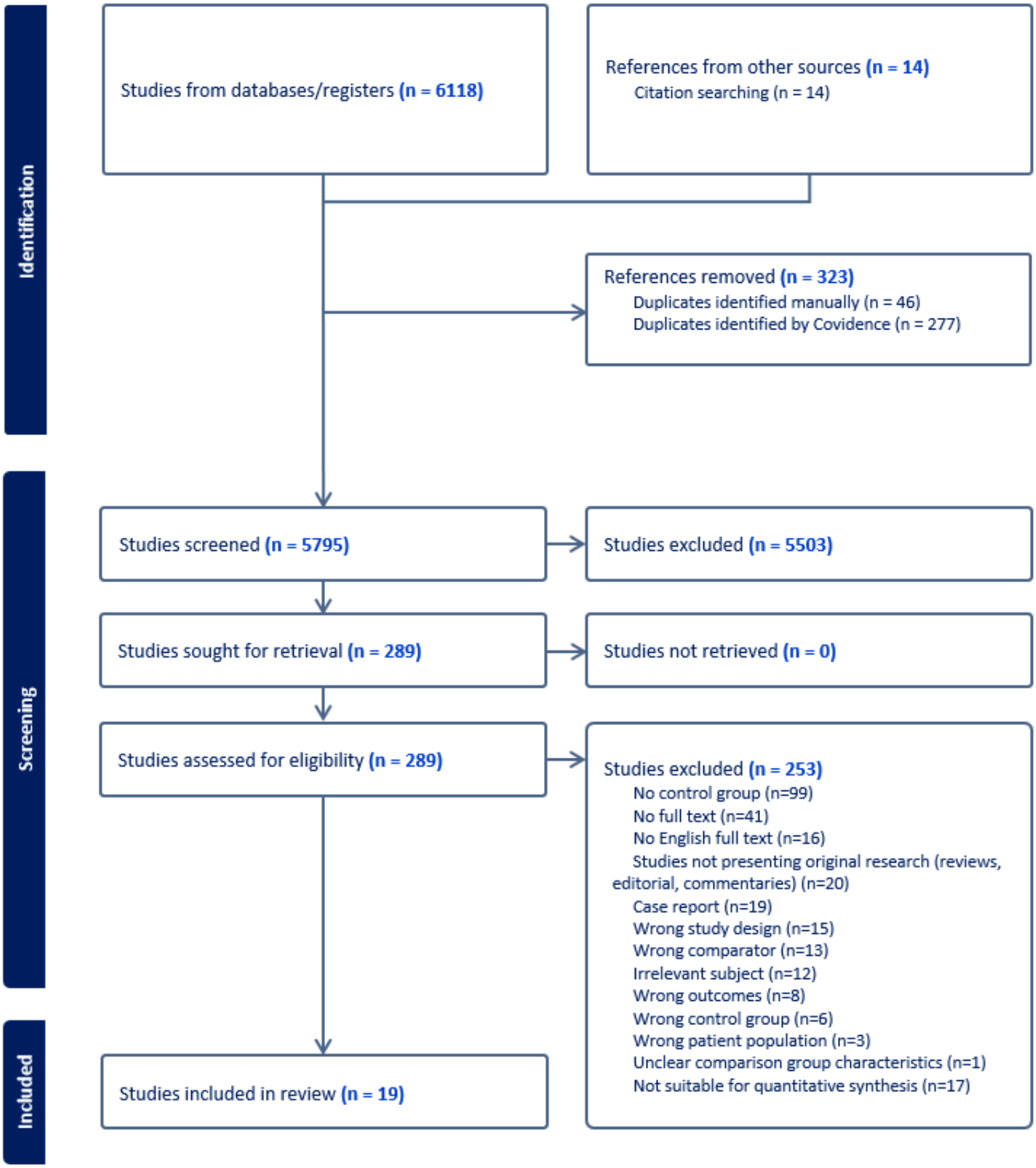

Figure 1

Flow diagram of the study selection process.

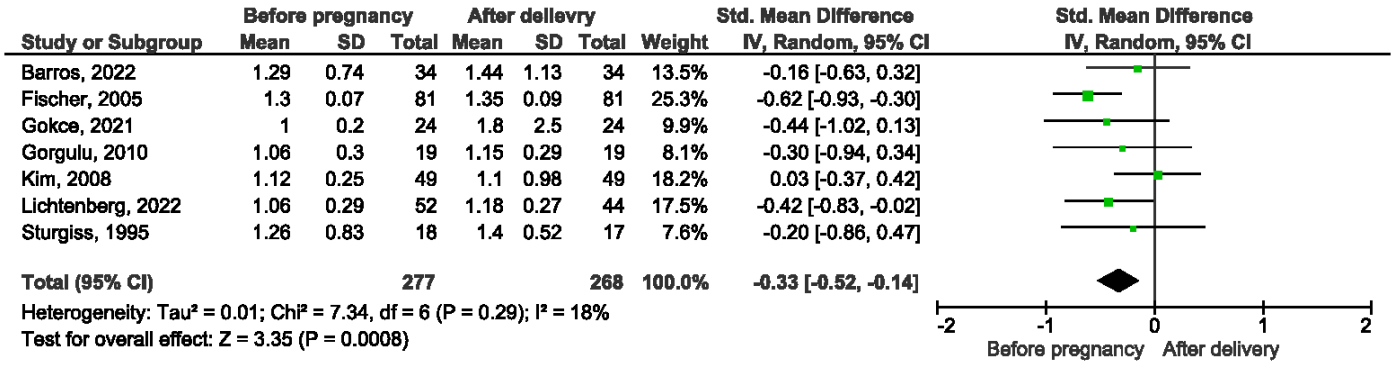

Figure 2

Creatinine levels before pregnancy versus in the post-delivery period.

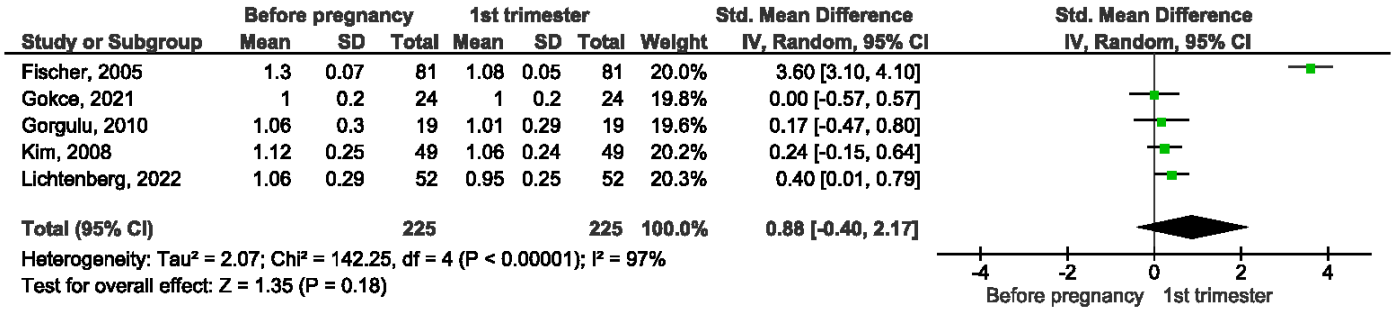

Figure 3

Creatinine values before pregnancy versus in the first trimester.

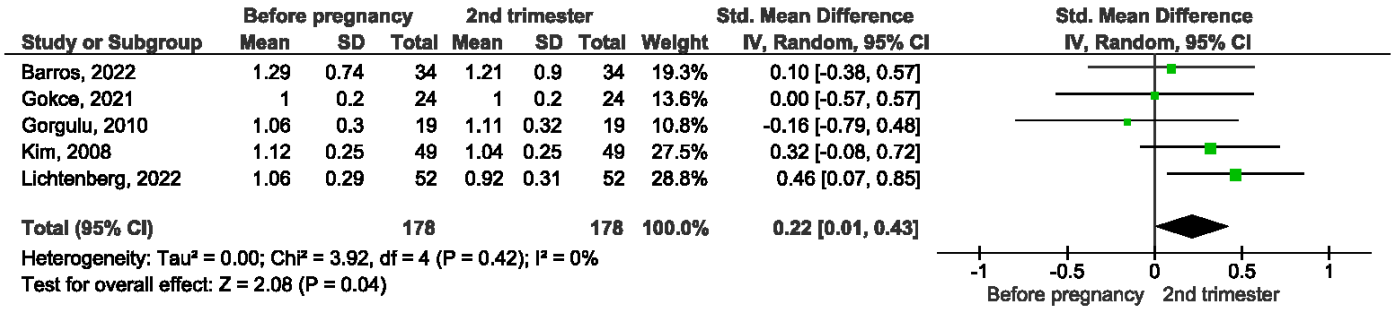

Figure 4

Creatinine values before pregnancy versus in the second trimester.

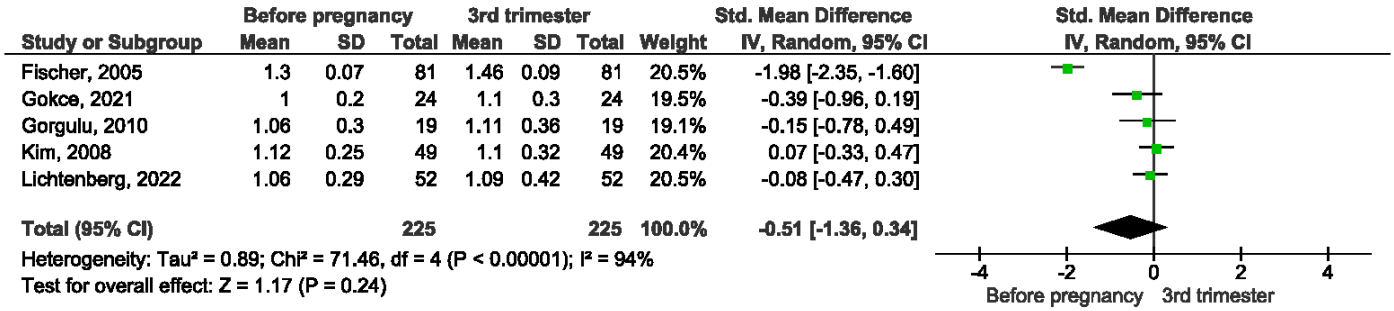

Figure 5

Creatinine values before pregnancy versus in the third trimester.

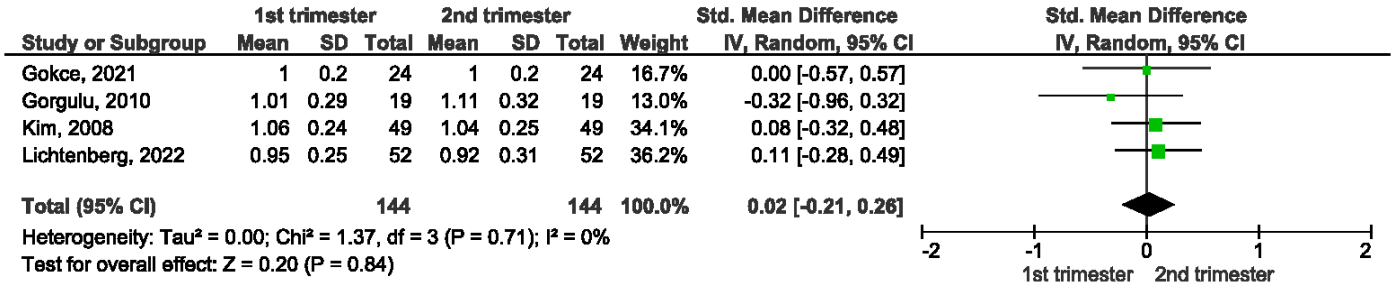

Figure 6

Creatinine values in the first trimester versus the second trimester.

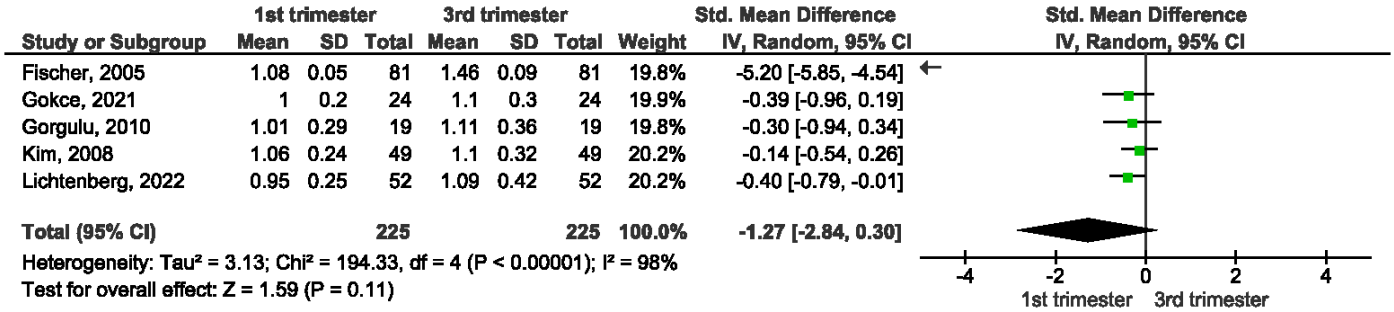

Figure 7

Creatinine values in the first trimester versus the third trimester.

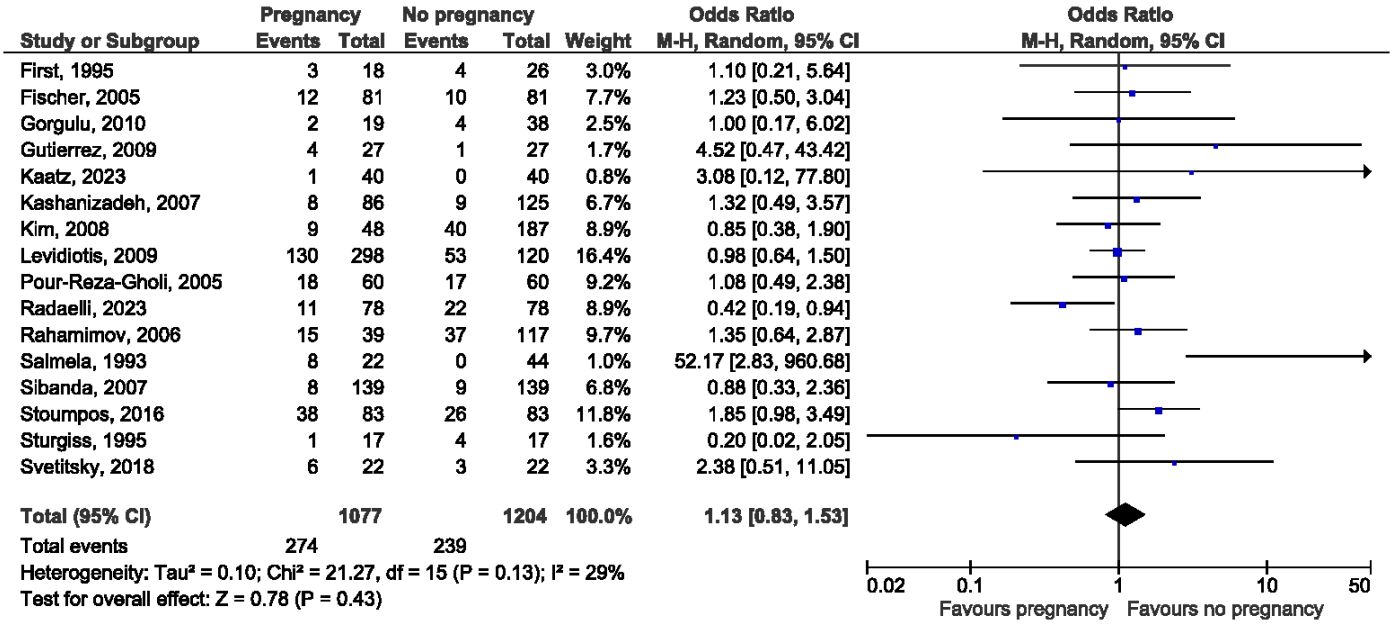

Figure 8

The risk of allograft failure of graft loss in pregnant and non-pregnant kidney transplant recipients.

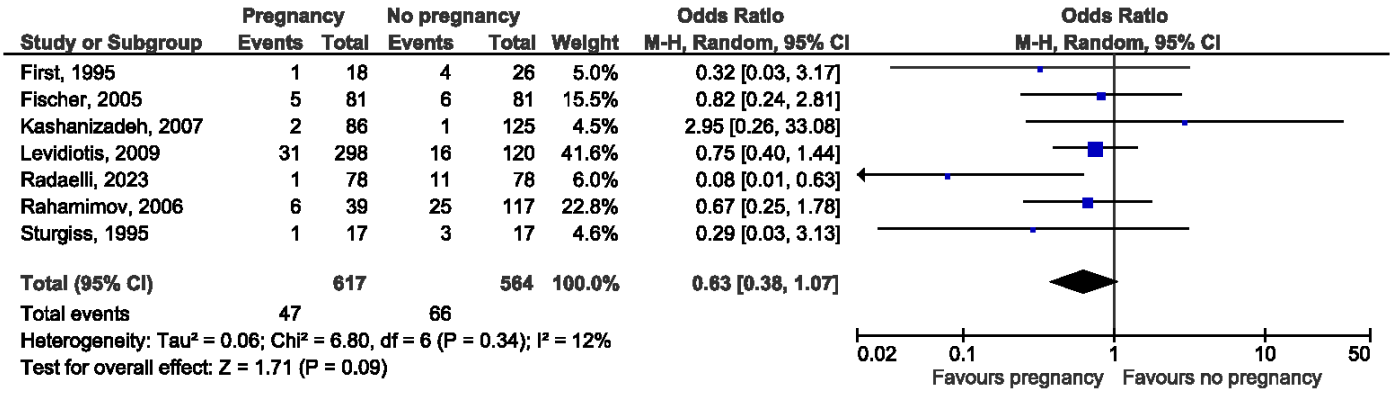

Figure 9

All-cause mortality risk in pregnant versus non-pregnant KT patients.

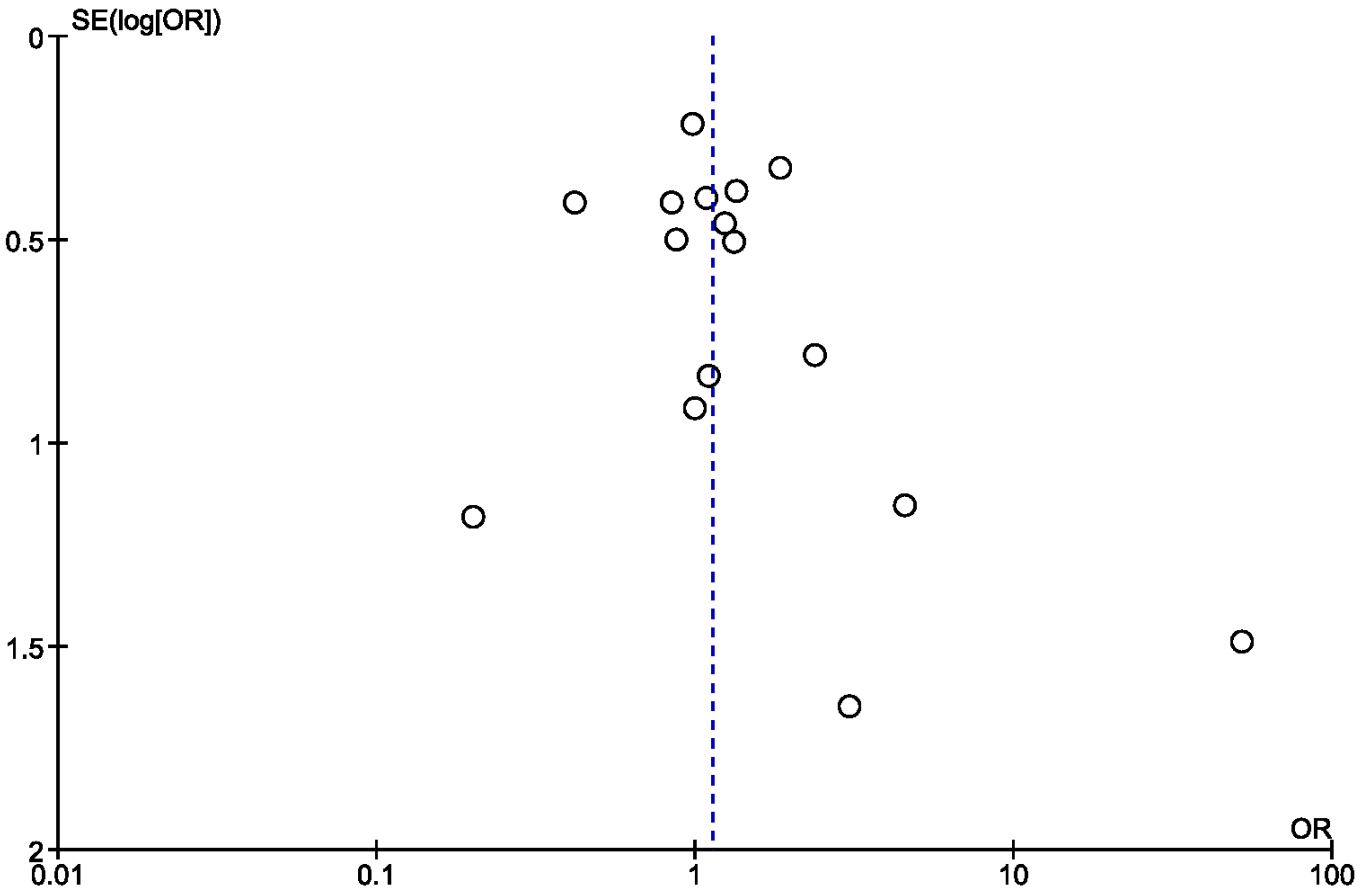

Figure 10

Funnel plot for assessing publication bias.

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- SupplementaryTableS1.docx
- SupplementaryTableS2andS3.docx