Author's response to reviews

Title: Utilization of antenatal ultrasound scan and implications for the caesarean section: a cross-sectional study in rural Eastern China

Authors:

Kun Huang (wuweihk8028@163.com)
Fangbiao Tao (fbtao@ahmu.edu.cn)
Joanna Raven (J.Raven@liverpool.ac.uk)
Liu Liu (ll1985to2005@yahoo.com.cn)
Xiaoyan Wu (wuxiaoyan_2005@hotmail.com)
Shenglan Tang (tangs@who.int)

Version: 2 Date: 18 July 2011

Author’s response to reviews: see over
Dear Editor,

We send the revised article “Utilization of antenatal ultrasound scan and implications for caesarean section: a cross-sectional study in rural Eastern China”. We have revised the manuscript according to the comments sent by the reviewers on 18 June 2011.

We are grateful to the reviewers for the very useful and constructive comments. We hope that we have addressed the concerns raised and that we are getting closer to an acceptable manuscript.

Below are the comments (in italics) made by the reviewers and our responses to these comments. All the authors have contributed to the revised manuscript.

Reviewer: Tine Gammeltoft

This paper addresses a significant global health problem: the overuse of medical technology in liberalized health care systems. The authors explore the use of antenatal ultrasound scanning and caesarean section in a rural area of China, finding 1) high rates of use of both technologies, 2) an association between the use of these two technologies: women with many ultrasounds also tend to have many C-sections.

General comments:
A strength of this paper is the overview of the literature on antenatal ultrasound that it offers (in the background/discussion sections): this review of the literature is very exact, comprehensive, clearly structured and provides the reader with an excellent overview over existing knowledge in this field. Another strength of the paper is that is it written in clear and comprehensible language.

The below comments must all be considered as major compulsory revisions. As I am an anthropologist, I have not assessed the statistics in this report.

The main weakness of the paper is that it fails to provide evidence for the main argument advanced: the authors argue that high rates of ultrasound cause high rates of C-section, yet this is not substantiated by the findings reported. To make this claim, the authors would need to know what events preceded the C-sections: to which extent were they clinically indicated and influenced by ultrasound results? Yes as the paper stands here, we are not offered this kind of information. The authors find (and provide evidence for) an association between ultrasounds and C-sections, but that does not necessarily involve a causal relation. The association could be explained by other things – such as, for instance, the inclination of health care providers in some settings to ‘push’ women to use these technologies (ie, in some medical settings, providers may promote these technologies more intently than in others, in an effort to generate revenue); or by local ‘reproductive cultures’ in which women encourage/inspire each other to embrace reproductive
technology. On the basis of the findings presented here, in other words, no firm answers can be provided to the question of how to account for the associations found. This should be acknowledged, and the authors may want to suggest ideas for future research that could look deeper into the factors behind such patterns in technology use.

Re: We agree with the reviewer’s comments. Indeed, our paper is based on a cross-sectional design and the data was collected by women’s own recall. Such a retrospective survey, to some extent, limits the conclusion of definite causality between antenatal ultrasound scan and caesarean section (CS). It is also a main limitation of this paper and has been added in the Discussion section about strengths and limitations (Page 11). The emphasis of the paper, however, is not to clarify the causality between ultrasound scan and CS. As there is high utilization of antenatal ultrasound examinations and caesarean sections in rural China, we have conducted this research and found an interesting association between antenatal ultrasound and CS. So we mainly want to interpret the possible reason of such an association, especially in the Discussion Section.

We have tried to search literatures relative to the association between antenatal ultrasound scan and its effect on CS. When we used the title words as “ultrasound and caesarean section”, it only came out a few literatures and most of them more focused on clinical aspects, such as clinical and ultrasound parameters to predict the risk of cesarean delivery after induction of labor, the effects of regional anaesthesia for caesarean section on maternal and fetal blood flow velocities measured by Doppler ultrasound, or using ultrasound to examine caesarean section scars during pregnancy or after childbirth. Some studies mentioned the possible mediating factor, ie. assessed fetal size, between antenatal ultrasound and CS. For instance,


Therefore, under the condition that there are few literatures interpreting the direct relationship between ultrasound and CS, we tried to account for the contribution of antenatal ultrasound scan to CS choice from the following two points of views:

1) To use more appropriate statistical strategies.

During initial data analysis, we had used logistic regression model (choice of CS as the dependent variable) to explore the effect of antenatal ultrasound scan on CS. After controlling for maternal age, education level, family annual income, antenatal care, adverse previous pregnancy outcomes, pregnancy complications, parity, the OR value of antenatal ultrasound numbers was 1.308 (95%CI 1.226-1.396). However, we had noticed that there existed complicated interactions among independent variables, for instance, demographic factors (maternal age, education level) and ultrasound, ultrasound and obstetric factors (parity, pregnancy complications, antenatal visit).
Traditional regression model was not able to display these detailed relationships and pathways, and strong correlations within factors also caused difficult or contradictory interpretation as well. Therefore, we provided a structural equation model (SEM) for analysis, a statistical technique specific for testing and estimating “causal” relationships using a combination of statistical data and qualitative causal assumptions, which could be used to better map and understand the effect of antenatal ultrasound scan on an increase in CS. Of course, these “causal” relationships were cross-sectional based.

From the SEM findings, we have got statistical significant direct relationship between ultrasound and CS (with the direct effect of 0.188) and an indirect association among antenatal ultrasound scan, pregnancy complications and CS (with the indirect effect of 0.007), more possibly through direct way. We think it’s more accurate to explain and compare the relationships by using these standardized estimates (ie. direct and indirect effects) from SEM than odds ratios generated from logistic regression model.

2) To explain the obtained direct and indirect relationships from a professional point of view.

a. For the direct relationship between ultrasound, we tried to say that maternal anxiety generated from ultrasound scan may increase their choice of CS. And also, when nuchal cord was found or fetal weight was estimated to be high by ultrasound scan, it would also add stress of physicians. They were more inclined to suggest CS to avoid potential risks during labor and delivery care.

b. For the indirect effect, we thought that ultrasound scans could identify more pregnancy complications, which could be the indicators of CS or increase demander’s and provider’s intention to CS.

All-above explanations are author’s assumption for the findings. As the reviewer mentioned, we must acknowledge that in our paper we can not give firm answer to which extent are so many caesarean section influenced by ultrasound results. Further research is needed by: i) a prospective cohort study to accurately evaluate the risk of CS in women who were exposed to (more) antenatal ultrasound scans and to provide a more necessary and accurate causality between ultrasound scan and CS. ii) a qualitative design to deeply explore stakeholders’ perceptions on provision and utilization of antenatal ultrasound scan and its association with CS choice.

The explanations the reviewer had considered, ie, provider’s push to escape responsibilities or generate income (Page 8), and maternal demands for medical technologies (Page 9) have been added in the Discussion section.

Specific comments:

Background section:

The authors note that ultrasounds have by now become widely accepted. Yet this is a truth with modifications: the routine utilization of ultrasound has occurred only in some parts of the world, and particularly in Euro-America and Asia. The authors may want to reflect on this globally patterned use of the technology.

Re: We have reflected on this globally patterned use of the technology in the Background section
We are informed that the CS rate has increased rapidly in China between 1993 and 2003. It would be interesting to hear more about what has caused this rapid increase? How much of the increase can be attributed to problems identified through ultrasounds and how much must be attributed to other factors? What is the state of knowledge in this field?

Re: Indeed, the CS rate has dramatically increased in China between 1993 and 2003. According to literature review and other findings in our research team, we have added more information about the causes of rapid increase in CS rate in Discussion section (Page 10 and 11).

When exploring the determinants of CS in rural China in another manuscript, we had found a stable association between antenatal ultrasound scans and CS. It arouses our interests and we have tried to do some literature review on this field. As it mentioned above, most of articles more focused on clinical aspects about the relationship between antenatal ultrasound and CS, or adopted assessed fetal size as the mediating factor. And in China, only one study by Mei Li has been found to evaluate the prediction of fetal weight by ultrasound and the consequent CS (Li M, Xing LL, Liu Y, Jin RF: Ultrasonographic prediction of fetal weight and the caesarean section resulting from it. Chinese Journal of Birth Health & Heredity 2005, 13: 82-3). So we report our findings in this paper and try to interpret the possible reasons based on other indirectly relative literatures and Chinese rural practice.

Results

The results section is extremely brief (too brief). It would strengthen the article if the authors could provide more findings on the C-sections: who made the decisions to have them (in half of the cases, the decision was made by the women, who made the decisions in the other cases?)? How many were planned and how many were emergency C-sections? What role did ultrasound scanning results play in the decision to undertake a caesarean delivery? What other factors weigh in?

Re: We have provided more information on the CS decision-maker apart from women in the Results section (Page 7).

As to the planned and emergency CS, however, we can’t distinguish them so clearly in our study. On one hand, it is difficult to get exact answers from women’s recall because of some women’s low educational level, some women’s inadequate involvement in decision-making and some provider’s induction even there are no obvious CS indications. On the other hand, quality of patients’ notes in rural hospitals needs improvement. Considering the limited information by women, we had randomly selected 600 questionnaires, went back to women’s delivery hospitals and checked their notes for more delivery information. But it was a pity that there was no clear description about planned or emergent CS. There were just some indications in the notes and we can’t clearly tell whether they happened during pregnancy or during labor. And also, many women even decided their delivery mode until when they had stomachache and were sent to hospitals. So it’s really a limitation in our study and has been stated in the Discussion section (Page 11). To
conduct deeply research, more accurate and subtle classification of CS should be defined.

About the role ultrasound scanning played in the decision to undertake a caesarean section, we had adopted structural equation model and used standardized regression weights (Table 3) to illustrate contributions for each variables. Compared with traditional logistic regression model, it can better map and understand the effect of antenatal ultrasound scan and its interaction with other determinants on an increase in CS.

We have given more detailed description of other factors in the model contributing to the choice of CS in Results section (Page 7). And also, in the Discussion section, we have added some information on causes of CS through findings from additional qualitative study by our research team (Page 11). It aims to demonstrate that many other social and cultural reasons apart from antenatal ultrasound have resulted in CS.

Regarding ultrasounds: the authors describe the demographic factors that impact ultrasound use – but it would be interesting to hear more about what women themselves said about what motivated them to obtain ultrasounds. If the structured questionnaire included such questions, the findings should be included in the results section.

RE: We agree with the reviewer’s suggestion. Women, without a doubt, have many reasons to take antenatal ultrasound scans. Gudex C et al had completed a research in Denmark to investigate women’s reasons for requesting antenatal ultrasound in the absence of clinical indications (Gudex C, Nielsen BL, Madsen M: Why women want prenatal ultrasound in pregnancy. *Ultrasound Obstet Gynecol* 2006, 27: 145-50.). It appeared that women in normal pregnancy had specific reasons for wanting prenatal ultrasound that were influenced by demographic, obstetric and attitudinal factors. They found items most frequently identified as important reasons for ultrasound were to check for fetal abnormalities (60% of women), to see that all was normal (55%) and for own reassurance (44%). Lower income was related to wanting to see the baby and wanting an ultrasound picture; higher income was related to checking that all was normal and for own reassurance. Women in their first pregnancy were more likely to want themselves and the father to see the baby; women who had given birth previously were more likely to want reassurance, as were women with a previous miscarriage or induced abortion. Women in the second trimester were more likely to want to check for abnormalities and appropriate fetal growth than those in the first trimester.

In another systematic review on women’s views of pregnancy ultrasound, it revealed that ultrasound was very attractive to women and families. Women often lacked information about the purposes for which an ultrasound scan was being done and the technical limitations of the procedure. The strong appeal of diagnostic ultrasound use may contribute to the fact that pregnant women were often unprepared for adverse findings (Garcia J, Bricker L, Henderson J, Martin MA, Mugford M, Nielsion J, Roberts T: Women’s views of pregnancy ultrasound: a systematic review. *Birth* 2002, 29: 225-50.). Both the two references have been cited in Discussion section (Page 9).

In our paper, high maternal education level, primiparity, adverse obstetric history and antenatal care were found to be directly associated with utilization of antenatal ultrasound scans. Maternal age appeared to have dual indirect effects on women’s use of ultrasound screening: younger
women are more likely to be primiparous and women in their first pregnancy are more likely to have more scans. Older age with more adverse outcome in previous pregnancy was another reason for wanting this antenatal technology. Different from Gudex’s findings, our study didn’t show any significant impact of family income on the ultrasound utilization (the income variable was removed from the structural equation model because it appeared a non-significant association and affected model fits). Effects of potential cultural and social factors may overtop the economic influence on use of antenatal ultrasound scan. Although in our questionnaire there was not so detailed information on why women with these specific demographic characteristics would choose ultrasound scans, we are also very interested in women’s words about the technology. Further study, especially qualitative study is expected to be organized to explore stakeholders’ perception on antenatal ultrasound scan and CS, including service demanders’ knowledge of ultrasound scan, motivation to have scans, emotions of assessed outcomes and the impacts on delivery mode; also including service providers’ knowledge of ultrasound scan, their motivation to prescribe ultrasound scans, response to adverse assessed fetal development and the effects on suggestion of delivery mode. These have been also described in limitations of Discussion section (Page 11).

Discussion

Some of the issues brought up in the Discussion section (such as the questions of the benefits/risks of ultrasounds) should be placed in the Background section.

RE: We have re-organized the paragraph in Background section and Discussion section according to reviewer’s comments.

The discussion should be focused more directly on the findings of this study: 1) the rates of ultrasound use among different groups of women, 2) the rates of C-section among different groups of women, 3) the possible connections between the use of these two technologies.

RE: We have re-organized Discussion section according to reviewer’s comments.

Reviewer: Xing Lin Feng

Using cross sectional household survey data, this paper analyzed the association between maternal factors, uptake of ultrasound scan and Caesareans sections in two counties of China. The authors concluded that “A high utilization of antenatal ultrasound screening was observed... Maternal age, education level, parity, obstetric history and antenatal care were found to be associated with high ultrasound use. Antenatal ultrasound scan contributes to CS in rural China and social causes may explain more of the association...”

My comments are as follows.

Major Compulsory Revisions
1. A recent systematic review and meta-analysis as referred below concluded that ultrasound scan is safe for pregnancy outcomes. Therefore safety argumentation is not proper to support the motivation of this research. And the second paragraph in the introduction is abundant.


RE1 Many thanks for reviewer’s comments and literature. We have read this systematic review very carefully. According to the available evidence, the authors said that ultrasonography in pregnancy was not associated with adverse maternal or perinatal outcome, impaired physical or neurological development, increased risk for malignancy in childhood, subnormal intellectual performance or mental diseases. Although the authors concluded that exposure to diagnostic ultrasonography during pregnancy “appeared” to be safe, they also pointed out the main limitations of this systematic review:

1) None of the included studies stated that assessing possible adverse bio-effects of ultrasound was one of their specific objectives;

2) This systematic review included mostly exposures before 1995 (24 of 40 studies included in the Result section were published before 1995), when the acoustic potency of the equipment used was lower than in modern machines. Over the years, there has been a continuous trend of increasing acoustic output, and the findings of this systematic review do not necessarily apply to currently used equipment;

3) Quantification of the intensity of acoustic exposure and duration of examination was lacking in almost 90% of the included studies. Even if these measures had been provided, research into the effects of ultrasound exposure is complicated by the fact that there is no way of objectively measuring the dose of energy absorbed;

4) Protocol deviations were also reported in almost all of the controlled trials included in this systematic review, mostly involving control women being exposed to unscheduled ultrasound for various clinical reasons, which could potentially affect the results reported by these studies. Because prenatal ultrasound is now commonplace, it may be difficult to perform randomized controlled trials without significant crossover. Particularly in developed countries, it would be difficult to recruit women willing to be randomized to a possible non-exposed control group;

5) This systematic review also included observational studies. The results of observational studies should be interpreted with caution since the possibility for confounding was large.

So the authors said the findings of this systematic review should be interpreted with caution. Safety implies absence of any deleterious effect, recognized or unrecognized, and it must be kept in mind that deleterious effects resulting from ultrasound may be subtle and appear many years after exposure. To answer questions about the effect of ultrasound on human development, long-term follow-up of exposed and unexposed infants is recommended.

In Torloni’s meta-analysis there was no association between ultrasound exposure and non-right handedness among all children, while there was an association among boys (Torloni MR, Vedmedovska N, Merialdi M, Betrán AP, Allen T, González R, Platt LD; ISUOG-WHO Fetal Growth Study Group;
Safety of ultrasonography in pregnancy: WHO systematic review of the literature and meta-analysis. Ultrasound Obstet Gynecol 2009, 33: 599-608.). But the paper by Heikill¨a K et al (Heikkilä K, Vuoksimaa E, Oksava K, Saari-Kemppainen A, Iivanainen M, Iivanainen M: Handedness in the Helsinki Ultrasound trial. Ultrasound Obstet Gynecol 2011, 37: 638-42.), may alter the findings of these systematic reviews. In a new meta-analysis, it was found that non-right handedness among all children was statistically significantly increased when the Helsinki data were included (Salvesen KA: Ultrasound in pregnancy and non right-handeness: meta-analysis of randomized trials. Ultrasound Obstet Gynecol 2011, DOI:10.1002/uog.9055). Recently, Salvesen KA et al advocate that Doppler examination of fetal vessels in early pregnancy should not be performed without a clinical indication because Doppler usually generates higher intensity outputs than does B-mode ultrasound and people now still live with uncertainty regarding ultrasound safety (Salvesen KA, Lees C, Abramowicz J, Brezinka C, Ter Haar G, MarSál K: Safe use of Doppler ultrasound during the 11 to 13 + 6-week scan: is it possible? Ultrasound Obstet Gynecol 2011, 37: 625-8.). Current evidence suggests that the use of Doppler ultrasound in high-risk pregnancies reduced the risk of perinatal deaths and resulted in less obstetric interventions (Alfirevic Z, Stampalija T, Gyte GM: Fetal and umbilical Doppler ultrasound in high-risk pregnancies. Cochrane Database Syst Rev 2010, (1): CD007529.). But routine fetal and umbilical Doppler ultrasound examination in low-risk or unselected populations did not result in increased antenatal, obstetric and neonatal interventions, and no overall differences were detected for substantive short term clinical outcomes (Alfirevic Z, Stampalija T, Gyte GM. Fetal and umbilical Doppler ultrasound in normal pregnancy. Cochrane Database Syst Rev 2010, (8): CD001450). Two animal studies have demonstrated a relationship between length of exposure to Doppler ultrasound and potentially irreversible biological effects (Schneider-Kolsky ME, Ayobi Z, Lombardo P, Brown D, Kedang B, Gibbs ME: Ultrasound exposure of the foetal chick brain: effects on learning and memory. Int J Dev Neurosci 2009, 27: 677-83; Ang ES Jr, Gluncic V, Duque A, Schafer ME, Rakic P: Prenatal exposure to ultrasound waves impacts neuronal migration in mice. Proc Natl Acad Sci U S A 2006, 103: 12903-10.). It revealed that when exposed to ultrasound for a total of 30 min or longer during the period of embryonic neurons migration, a small but statistically significant number of neurons failed to acquire their proper position and remain scattered within inappropriate cortical layers and/or in the subjacent white matter. Current epidemiological evidence is not synchronous with advancing ultrasound technology and an absence of evidence of harm is not equal to evidence of absence of harm.

Since in China, there is a high use of both antenatal ultrasound and CS and no firm evidence to show that it is at zero risk to expose to prenatal ultrasound scan, we think it’s important to conduct such a study to understand the factors related with high utilization of antenatal ultrasound and the association between antenatal ultrasound and CS. It will attract maternal policy-makers’ more attention on this issue and provide evidence for their decision-making. With increasing use of these two technologies, health-care systems will undoubtedly face even higher associated costs, so it will make much more sense in developing countries with limited and imbalanced medical resources.

After reading these latest literatures, we acknowledge that the second paragraph in the Introduction section was not written very well. We have re-organized the paragraph according to the above-mentioned literatures and added information on the importance to conduct this study.
2. Guo et al (2007), referred as 51 in the manuscript, reported the positive association of ultrasound scan in pregnancy and the rising Caesarean sections in China. Therefore it is unfair to motivate this research by saying that “there are limited data on the utilization of antenatal ultrasound scan in the general population, including its association with CS” as in the last paragraph of the introduction section.

RE: We agree and have modified this sentence.

3. The analysis needs major improvement. All the factors as specified in the structural equation model (figure 2) are maternal factors; while the authors totally ignored the supply side factors. However, both demand and supply side arguments have been put forward on why Caesareans sections have been rising so rapidly in China. The misspecification of the structural model may make the positive association of ultrasound scan and Caesareans section spurious. For example, if doctors just want to provide more ultrasound scan and Caesareans section to make money (as argued by Bogg et al 2010 and Long et al, 2011), the two variables are definitely associated. However, the association is spurious because ultrasound scan per se does not necessarily lead to Caesarean sections. I quote the argumentation of Guo et al (2007) here for the authors’ information. “The availability and widespread use of ultrasound scanning indicates the extent of use (medicalization) of antenatal care services by women in the study area and could be either a marker for a type of patient who prefers medical intervention, or a marker for a type of medical behaviour whereby doctors might be inclined to offer both scanning and caesarean delivery.”

RE: We fully understand the reviewer’s consideration. Indeed, there are very complicated reasons for CS in rural China from demanders, suppliers, society and cultures. We had carried out a special qualitative research to explore both service users’ and providers’ perceptions on CS. These findings have been quoted in Discussion section (Page 10 and 11) to enrich the causes of increasing CS rate in rural China.

In this quantitative research in our paper, health providers’ characteristics, such as physician’s demographic data, institution’s information, were not systematically collected. Obviously it is a limitation and we also feel difficult to put all demander’s and provider’s data into one statistic model.

The objective of this paper is to investigate determinants of antenatal ultrasound scans and to explore the association between antenatal ultrasound scan and CS. All the information of this paper came from the women and we mainly focused on their “utilization” of ultrasound and CS, not on all round influencing factors of CS. We know that the association found between antenatal ultrasound and CS should be interpreted with caution just as the reviewer has commented. So the main task of the Discussion section is to give possible explanations of such an association based on relative literatures and Chinese rural practice. We have also added the reviewer’s comments into limitations of Discussion section (Page 11).

Minor Essential Revisions

4. In the data collection section, the authors stated that “there were no other
maternal health care improvement programs ongoing in the counties at the time of the study”. The authors describe none maternal health care improvement programs. Thus I don’t understand why they say “other” here. If they really have some programs in the two counties, it seems that there are no counties in China fulfilling such criteria. It is reported (Long, 2010) that the New Collaborative Medical Scheme (NCMS) has covered more than 90 percent of rural population in China.

RE: Sorry we didn’t explain the details for the project in Method. The data of this paper is generated from a broader international project “Structural hinders to and promoters of good maternal care in rural China – CHIMACA. It intended to find out the hinders in good maternal care in rural China and accordingly frame community interventions to improve access and quality of maternal health care. New Collaborative Medical Scheme (NCMS) was a required condition for the study sites because one of interventions was made based on the NCMS system. Qian Long, the author of the literature the reviewer quoted here is also a team member of CHIMACA project. As to the two counties in our paper, FC had introduced NCMS in 2005 and XC did in 2007. The intervention initiated in 2008. So to avoid the “contaminations” among programs and to clearly evaluate the effects of intervention as well, one of criteria to select the study sites was “there were no other maternal health care improvement programs ongoing in the counties at the time of the study”. This has been added in Method section (Page 5).