Response to Reviewer 2 Comments

Point 1: The paper considers the shape changes in women before, during, and after pregnancy. Authors develop techniques to accurately predict the body proportions of pregnant and postpartum women based on simple tape anthropometric measurements.

Response 1: We thank the reviewer for the careful and insightful review of our manuscript.

General remarks:

Point 2: The paper seems to be written by at least two different researchers since the language and clarity of presentation are changing. Therefore, I would suggest, researchers, consolidate the paper and give the paper to a native speaker for editing.

Response 2: This article was written in collaboration of multiple authors. We believe the manuscript should represent the views of all authors, not only the part of their own contribution. Hence, the content consistency and language might show discontinuity. We have carefully consolidated the manuscript and sent it to the Professional Authorship Center, Thailand National Science and Technology Development Agency (NSTDA) for review and revision. Thanks for your advice. We will submit the manuscript to editing services (MDPI Author Services) for revisions by native English-speaker in minor revision after completing major revision correction.

Point 3: The structure and importance of each section could be also edited for improving the paper. While methods and materials seem to be quite extensive and some of it could be moved to the results section; the results section and especially the discussion section are rather sparse and short.

Response 3: We are grateful for your suggestion. The following parts were moved from the Method section to the Result section:

- Table 2. Coefficient values for the multiple linear regression of pregnant women.
- Figure 4: The simulated 3D model before pregnancy and during pregnancy 12, 24, and 40 weeks with four types of pre-pregnancy BMI: underweight, normal weight, overweight and obese respectively.
- Table 6. Coefficient values for the multiple linear regression of postpartum women.
- Figure6: 3D simulation models of postpartum women.

Specific remarks:

Point 4: Abstract section:

Response 4: Edited Abstract (193 words)

Abstract: Several studies have reported that pre-pregnant women's body mass index (BMI) affects women's weight gain with complications during pregnancy and the postpartum weight retention. It is important to control the BMI before, during and after pregnancy. Our objectives are to develop a technique that can compute and visualize 3D body shapes of women during pregnancy and postpartum in various gestational ages, BMI, and postpartum durations. Body changes data from 98 pregnant and 83 postpartum women were collected, tracked for 6 months, and analyzed to create 3D model shapes. This study allows users to simulate their 3D body shapes in real-time and online, based on weight, height, and gestational age, using multiple linear regression and morphing techniques. To evaluate the results, precision tests were performed on simulated 3D pregnant and postpartum women's shapes. Additionally, a satisfaction test on the application was conducted on new 149 mothers. The accuracy of the simulation was tested on 75 pregnant and 74 postpartum volunteers in terms of relationships between statistical calculation, simulated 3D models and actual tape measurement of chest, waist, hip, and inseam. Our results can predict accurately the body proportions of pregnant and postpartum women.

Comment: Abstract section:

Point 5: Abstract section:

Response 5: We thank the reviewer for these suggestions. The abstract is limited in word count, so we edited the abstract with a short explanation regarding reviewer question and additional explanation in the Discussion section.

Point 6: "Our objectives are to develop a technique that can compute and visualize 3D body shapes of women during pregnancy and postpartum in various forms." – what forms? Explain in manuscript

Response 6: We edited the Abstract with a short explanation as "Our objectives are to develop a technique that can compute and visualize 3D body shapes of women during pregnancy and postpartum in various gestational ages, BMI, and postpartum durations."

Further explanation is also added in the Discussion section

"Also, our developed technique can simulate 3D body shapes of women during pregnancy and postpartum in various gestational ages, BMI, and postpartum duration as shown in figure 5 and 6, respectively. The pregnancy simulation included various gestational ages starting from 12-40 weeks with four types of pre-pregnancy BMI: under-weight, normal weight, overweight and obese, and the postpartum at 0-24 weeks."

Point 7: "Changes in body according to 587 datasets from 98 pregnant and 503 datasets from 83 postpartum women were collected for 6 months tracking and analyzed for model shapes' calculation." – What is meant by datasets? Explain in the manuscript.

Response 7: The sentence has been revised to make it simple in the abstract to "Body changes data from 98 pregnant and 83 postpartum women were collected, tracked for 6 months and analyzed to create 3D model shapes."

More details of 587 data collected from 98 pregnant women were explained in Section 3.2 as follows. "The data from 98 pregnant women volunteers were collected and analyzed. Information of all pregnant volunteers is shown in Table 1. The data were 587 sets in total. Each data contained woman's age, pre-pregnancy weight, height, gestational age, weight gain during pregnancy, inseam (measure once at 12–16 week pregnancy), and body circumference measurements: chest, waist, hip, upper arm (left/right), and thigh (left/right). The data used for this study were from 94 women who were 12-week gestation; 98 of 16-week gestation; 91 of 20-week gestation; 82 of 24-week gestation; 79 of 28-week gestation; 78 of 32-week gestation and 65 of 36-week gestation, a total of 587 sets."

More detail of 503 data collected from 83 postpartum women volunteers were explained in Section 3.4 as follows. "The data from 83 postpartum women volunteers were collected and analyzed. Information of all postpartum volunteers was shown in Table 5. The data were 503 sets in total. Each data contains woman's age, pre-pregnancy weight, height, gravida, baby weight, postpartum week, postpartum weight, inseam (measure once at 0 week of postpartum), and body circumference measurements: chest, waist, hip, upper arm (left/right), and thigh (left/right). The data used for this study were from 81 women of 0-week postpartum; 76 of 4-week postpartum; 73 of 8-week postpartum; 72 of 12-week postpartum; 72 of 16-week postpartum; 70 of 20-week postpartum and 59 of 24-week postpartum, a total of 503 sets."

Point 8: "Our results can predict accurately the body proportions of pregnant and postpartum women." – based on what input? Provide this info in manuscript

Response 8: We add this paragraph to the Conclusion section. "Our web app (Z-Size Ladies) accurately predicts the body proportions of pregnant and postpartum women based on woman's age (years), pre-pregnancy weight (Kg), height (cm), gravida (number of pregnancies, the default is 1), pregnancy/ gestational week (weeks) and weight gain (program predicted automatically with adjustable personalized input from the user)."

1. Introduction:

Point 9: "There are several researches looking at correlations of body shapes and BMI for women." – please provide references.

Response 9: Thank you for pointing this out. We added three references as follows:

There are some research reports looking at correlations between body shapes and BMI for women [14, 15, 16].

References:

[14] Simona F.P., Elisabeta R.L., Cristian R. M. Relation Between Body Shape And Body Mass Index. Procedia - Social and Behavioral Sciences. Volume 197, 25 July 2015, Pages 1458-1463. DOI: 10.1016/j.sbspro.2015.07.095

[15] Kang N.E., Kim S.J., Oh Y.S., Jang S. The effects of body mass index and body shape perceptions of South Korean adults on weight control behaviors; Correlation with quality of sleep and residence of place. Nutr Res Pract. 2020 Apr; 14(2): 160–166. DOI:10.4162/nrp.2020.14.2.160

[16] Wells J.C., Treleaven P., Cole T.J. BMI compared with 3-dimensional body shape: the UK National Sizing Survey. The American Journal of Clinical Nutrition, Volume 85, Issue 2, February 2007, Pages 419–425. DOI: 10.1093/ajcn/85.2.419

Point 10: "Nevertheless, there is no physical simulation or any way to find the shape proportion of pregnant and postpartum women, which are considered to be a population group with high health risks and vulnerability." – what risk? Provide references…

Response 10: Thank you, we have removed "high health risks". The sentence was revised and an additional explanation with a reference was added.

"Nevertheless, there is no physical simulation for the shape proportion of pregnant and postpartum woman subjects as they are a population group with vulnerability to use the 3D body scanner for their data collection. The word "vulnerable" is in the context of human research protections. Pregnant women are considered vulnerable because of the involvement of the fetus that may be affected by the research and the fetus cannot give consent [17]."

Reference:

[17] Pregnant Women, Fetuses and Neonates as Vulnerable Population. Human Research Protection Program, 2009. Available online at https://cphs.berkeley.edu/policies_procedures/sc501.pdf

Point 11: "It is not possible to make a direct data collection using the 3D body scanner." – why not? Explain in the manuscript. Provide also reference.

Response 11: Thank you for your question. We have clarified and rewritten the statement as follows:

"It was not possible to collect the body shape data using the 3D body scanner in this study. This is because most pregnant women are concerned about the safety of 3D body scanners and have questions about the scanner potential consequences at all stages of pregnancy [18]. It is difficult to obtain and approve applications for research projects involving human subjects from the IRB (Institutional Review Board), and especially when asking for consent forms from research subjects [17]. We also needed pregnant and postpartum women to help us for

measurement their body circumferences at home every four weeks during pregnancy and postpartum."

References:

[18] Pregnancy and Security Screening. Frequently Asked Questions in HPS Specialists in Radiation Protection, 2016. Available online at https://hps.org/publicinformation/ate/faqs/pregnancyandsecurityscreening.html

Point 12: "However, Body Visualizer has been using "Civilian American and European Surface Anthropometry Resource" (CAESAR) as the basis for creating Body Visualizer, which based on the data from SizeUSA while the result of the simulation is just a clay figure." – vague sentence. Please edit the manuscript with a native English speaker.

Response 12: Thank you for pointing this out to us. We have revised it as follows:

"Body Visualizer has used the SizeUSA dataset, American and European Surface Anthropometry Resource (CAESAR) as the basis for creating 3D body shapes visualization [28, 29]. It is a visualization tool for a parametric 3D body model that provides accurate metrically anthropomorphic measurements based on laser scans of thousands of people from different ethnicities. However, it is still lacking the 3D body models for pregnant and postpartum women, especially for Asian women. Therefore, our study focused on simulating 3D shapes of Thai pregnant and postpartum women."

References

[28] Loper, M., Mahmood, N., Romero, J., Pons-Moll, G., & Black, M. J. (2015). SMPL: A skinned multi-person linear model. ACM transactions on graphics (TOG), 34(6), 1-16.

[29] Osman, A. A., Bolkart, T., & Black, M. J. (2020). Star: Sparse trained articulated human body regressor. In Computer Vision–ECCV 2020: 16th European Conference, Glasgow, UK, August 23–28, 2020, Proceedings, Part VI 16 (pp. 598-613). Springer International Publishing

3. Methodology

Point 13: Figure 2. – what is meant with "Thin avatar with pregnant"?

Response 13: Thank you for the question. We have clarified and added the statement:

"Pregnant thin avatar refers to the pregnant women's simulation based on our previous studies [42]. Pregnant woman simulation is a combination of non-pregnant woman shape and pregnant shape. Because the non-pregnant female simulation is a combination of a thin avatar (Figure 3(A)) and other avatar shapes (including Figure 3 (B) big breast, (C) big waist, (D) big

hip, (E) tall avatar, (F) long legs). So a pregnant thin avatar (Figure 2 or Figure 3 (G)) is added to simulate a pregnant woman."

[42] Sinthanayothin C, Bholsithi W, Gansawat D, et al. Simulation of three-dimensional female body shapes with proportional representation for various weights and heights. SIMULATION. 2020;96(11):851-866. DOI:10.1177/0037549720944466

Point 14: Figure 3. – why different view/pose for avatar G?

Response 14: Avatar G has different view/pose in Figure 3 because we would like to emphasize that this avatar has been added to this study while other avatars are from our previous study. Avatars (A)-(F) are shown in 'front view'. However, if avatar G is shown in only 'front view', the shape changes from pregnancy would be difficult to notice.

Point 15: 4.3. The satisfaction test of the web app Z-Size Ladies v.2

This is not a part of this study and the authors also do not provide any discussion based on this. I suggest the authors remove this from the paper.

Response 15: Thank you for the suggestion. Although the satisfaction test of the web app Z-Size Ladies was not directly part of this study, this manuscript presents a tool that helps pregnant women to simulate their 3D body shapes based on their personalized height, weight, and gestational age. The validation of our developed application was carried out by means of a survey received from users. We have not removed this part from the revised manuscript but provided more information in the discussion as follows.

"This study presents a 3D model shape simulation of pregnant and postpartum women. The data of woman's anthropometric measurements in different gestational and postpartum stages were collected. Based on the work of our previous study [42], pregnancy data was included to generate models to predict the shape of women at specific pregnancy and postpartum periods, based on pre-pregnancy measurements. The work led to the creation of a web application (Z-Size Ladies) to display 3D pregnancy and postpartum models, allowing women to input their metrics and observe the simulation. The website was validated through a survey from the users and received positive satisfaction scores from pregnant and postpartum women as illustrated in Table 15."

[42] Sinthanayothin C, Bholsithi W, Gansawat D, et al. Simulation of three-dimensional female body shapes with proportional representation for various weights and heights. SIMULATION. 2020;96(11):851-866. DOI:10.1177/0037549720944466

5. Discussion

Point 16: "On the other hand, the lowest correlation is at the thigh measurement (Corr = 0.90191) due to the difficulty to locate the point for manual measurements of thigh, which

have to be near the crotch." – do you think this is the only error? What about the errors that could occur during statistical modeling? How do you account for that? Consider this also in all further occurrences. Please discuss this in the discussion section and provide relevant data.

Response 16: We fully agree with the reviewer. So, we added this paragraph and provided two more references to the discussion.

"Errors that could occur during statistical modeling in this study could come from the multiple regression models in the independent variables [56] such as pre-pregnancy weight, height, age, gestation age, and body circumferences measurements data (chest, waist, hip). Our regression models assumed that those variables and data were obtained from measurement without errors. Moreover, errors could come from a small sample size, which might lead to insignificant results, whereas a too large sample size may increase the risk of harming volunteer subjects and might cause them discomfort [57]."

References

[56] Errors-in-variables models. Wikipedia, 2022. Available online at https://en.wikipedia.org/wiki/Errors-in-variables_models

[57] Biau D. J., Kernéis S., and Porcher R. Statistics in Brief: The Importance of Sample Size in the Planning and Interpretation of Medical Research. Clin Orthop Relat Res. 2008 Sep; 466(9): 2282–2288. doi: 10.1007/s11999-008-0346-9

We have carefully consolidated the manuscript and sent it to the Professional Authorship Center, Thailand National Science and Technology Development Agency (NSTDA) for review and revision.



CERTIFICATE OF ENGLISH EDITING

This document certifies that the manuscript listed below was edited for English language by one of the highly qualified English editors with a Ph.D. at Professional Authorship Center (PAC), National Science and Technology Development Agency (NSTDA).

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