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Research Article

Growth and Body Development of Philippine Native Pigs in a Semi-Intensive Farm in Mindanao

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Abstract | Little is known about the growth patterns and body development of Philippine Native Pigs (PNPs) in Mindanao, despite their importance in smallholder and backyard production systems. We studied the growth patterns and body development of PNPs over time under a semi-intensive management system in Alabel, Sarangani Province. We followed 24 PNPs (9 males, 15 females) from birth to 8 months of age. The body weight and morphometric traits, including shoulder width, heart girth, midriff girth, flank girth, body length, and tail length, were measured at birth, 3, 6, and 8 months. Data were analyzed using linear mixed models. Body weight and all body measurements increased significantly with age ($p < 0.01$), showing steady growth and body development. Body weights increased progressively, reflecting a typical sigmoidal growth pattern. Mean body weight increased from 1.53 ± 0.54 kg at birth to 43.56 ± 18.44 kg at 8 months in males, and from 1.44 ± 0.41 kg to 41.40 ± 17.78 kg in females. Males and females did not differ significantly in body weight, body measurements or average daily gain (ADG) up to 8 months of age ($p > 0.05$). Morphometric traits increased significantly with age alongside body weight, indicating continuous growth and body development throughout the study period. ADG differed significantly among growth intervals, with greater variation at later stages suggesting possible heterogeneity in growth performance. Overall, these PNPs grew steadily and developed consistently under semi-intensive management. This study provides preliminary baseline growth and body measurement data for PNPs in Mindanao and may contribute to future genetic characterization, conservation and breed development efforts, although findings should be interpreted cautiously because the data were obtained from a single farm.

Keywords | Longitudinal study, Mindanao, Philippine native pigs

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INTRODUCTION

Pork is a popular meat in the Philippines. Due to the high demand for pork, pig farming is a key part in Philippine agriculture. The swine industry is a significant contributor to the national economy because it supports the food security of the country and provides livelihoods in rural communities (Fang and Elca, 2021; Bollido *et al.*, 2022). In fact, pigs make up about 55% of all livestock production, making it the largest contributor to the livestock sector in the country. It is primarily composed of commercial and backyard farms, which raise exotic pig breeds such as Large White, Landrace, and Duroc, with the majority raised in smallholder systems. In addition, many farmers still raise PNPs in rural areas (Acosta, 2022; Banayo *et al*., 2023; Fernandez-Colorado *et al*., 2024).

The PNPs are small but resilient. These pigs are native to the Philippines and are well adapted to local environmental conditions. They tolerate heat well, resist diseases, and remain important components of smallholder production systems in the country. The government has stressed the need to conserve native animal genetic resources, recognizing the cultural and economic importance of PNPs. The Department of Agriculture pushed for the implementation of the Philippine Native Animal Development Program, which aims to protect and promote the sustainable utilization of native livestock species, including the PNPs (Bureau of Animal Industry, 2023). PNPs are becoming more valuable as the pig industry faces challenges such as climate change and transboundary diseases, especially African Swine Fever (Fernandez-Colorado *et al*., 2024).

So far, several genetic groups of PNPs have been identified and developed across different regions of the Philippines through years of breeding and evaluation. These groups have been phenotypically described, and some have undergone genetic analysis. Previous studies using microsatellite markers, mitochondrial DNA, and candidate-gene approaches have reported limited or variable genetic diversity, possible inbreeding in some populations, population structuring, multiple maternal origins, and genetic markers related to production traits in PNPs (Octura *et al*., 2014; Oh *et al*., 2014; Logronio *et al*., 2022; Banayo *et al*., 2023). However, these studies also highlight the need to integrate genetic information with phenotypic and growth data to support the characterization and conservation of PNPs. Most studied populations come from Luzon and the Visayas. To date, there are six established genetic groups of PNPs, namely Q-Black, Markaduke, Sinirangan, ISUbela, Benguet and Yookah, which were developed in Quezon Province, Marinduque, Eastern Samar, Isabela, Benguet, and Kalinga, respectively (Figure 1). Also shown in the figure are the emerging or reported groups from Bohol and Batanes (Geromo *et al*., 2020; Dichoso *et al*., 2022). However, almost no studies have described or measured native pigs in Mindanao. No native pig group has been formally recognized in Mindanao yet, although early work has started in Zamboanga Peninsula. Because baseline data on morphometric characteristics and growth performance remain limited, comparisons between Mindanao PNPs and populations from Luzon and the Visayas are very difficult.

To our knowledge, this is the first study to track how PNPs in Mindanao grow over time. Therefore, as an initial step toward addressing this gap, the present study evaluated the longitudinal growth patterns and morphometric development of PNPs raised under a semi-intensive management system on a farm in Alabel, Sarangani Province, Mindanao. The findings provide baseline information to support future characterization and comparative analyses.

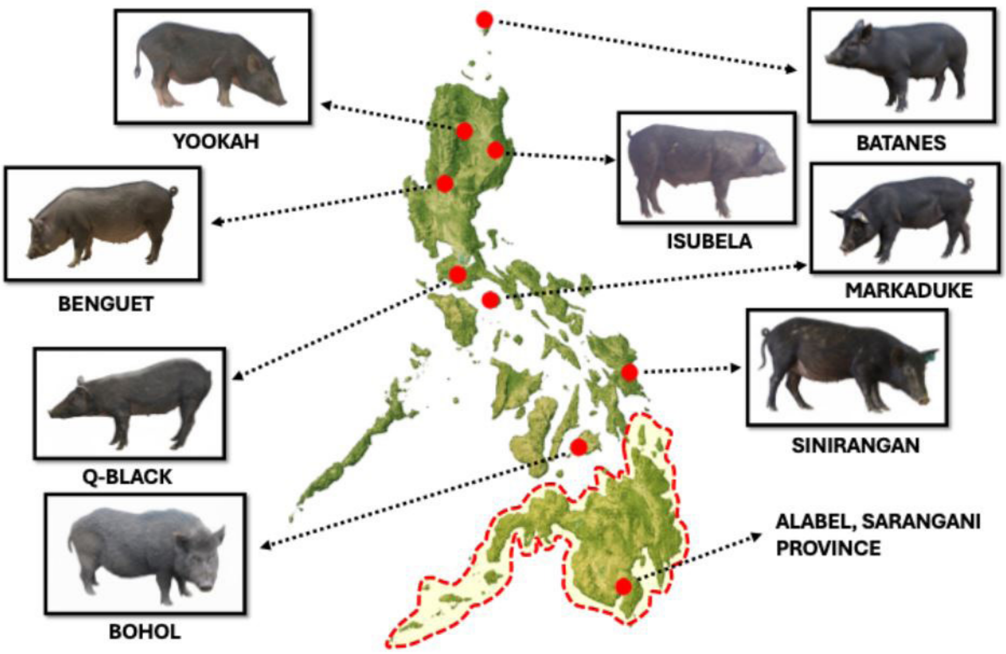

Figure 1: Geographic distribution of identified PNP genetic groups. The Mindanao region is indicated with no officially identified or developed native pig genetic group to date. The location of the morphological study conducted in Alabel, Sarangani Province is also highlighted. (Adapted from DOST-PCAARRD- 2022 reports on native pig genetic resources, with additional modifications by the authors).

MATERIALS AND METHODS

Animals and location of the study

This study was conducted on a farm that raises PNPs under semi-intensive management system located in Brgy. Tokawal, Alabel, Sarangani Province, Mindanao (6.174° N, 125.245° E). The farm maintains PNPs at different stages of growth. The pigs were fed twice daily, in the morning and afternoon, with a mixture of fermented forage, corn bran, molasses, and water. Fermented forage was prepared from madre de agua (*Trichanthera gigantea*), napier grass (*Pennisetum purpureum*), and other locally available plant residues and fermented for 14 days. Equal amounts of fermented feed and corn bran were provided as part of routine farm management. The ration was shared among pigs, while free grazing was allowed during the day. We did not determine individual feed intake because the PNPs were fed collectively and allowed to graze freely with other PNPs on the farm. Therefore, differences in growth performance could not be separated from possible differences in individual feed intake. Figure 2 shows representative photographs of adult male and female PNPs in the area, as well as housing structures at the study site. All animals were raised and managed in accordance with the Code of Good Animal Husbandry Practice for Swine issued by the Bureau of Agriculture and Fisheries Standards (BAFS, 2019).

A total of 24 PNPs (9 males and 15 females) from four different sows were included in this study. The piglets were derived from four litters with litter sizes of 4, 7, 5, and 8 piglets, respectively, and male-to-female distributions of 2:2, 2:5, 2:3, and 3:5. We followed the pigs from birth to 8 months of age. The body weights of the PNPs were recorded, as well as the different body morphometric measurements, specifically shoulder width, heart girth, midriff girth, flank girth, body length, and tail length.

We measured each pig at birth, 3 months, 6 months, and 8 months of age. Average daily gain (ADG) was calculated as the change in body weight divided by the corresponding growth interval, using standardized age periods of 90 days for the 0-3 and 3-6 months intervals and 60 days for the 6-8 month interval. All 24 PNPs completed the study and were successfully measured at all four sampling periods, with no missing observations. All morphometric measurements were taken by the same researcher using standardized procedures to minimize variation. However, measurement repeatability was not formally tested. These measurements allowed us to track growth from newborn to near-adult stages.

Measurements taken at birth provide baseline data and may reveal maternal or genetic influences. The measurements taken at 3 and 6 months capture the growth patterns during the post-weaning and juvenile stages. Measurements at 8 months of age were used to assess the pre-adult body development, overall growth trajectory and productivity potential. Although the PNPs continue to grow beyond 8 months of age, this endpoint was selected to capture much of the post-weaning and pre-adult growth phase while remaining practical under field conditions.

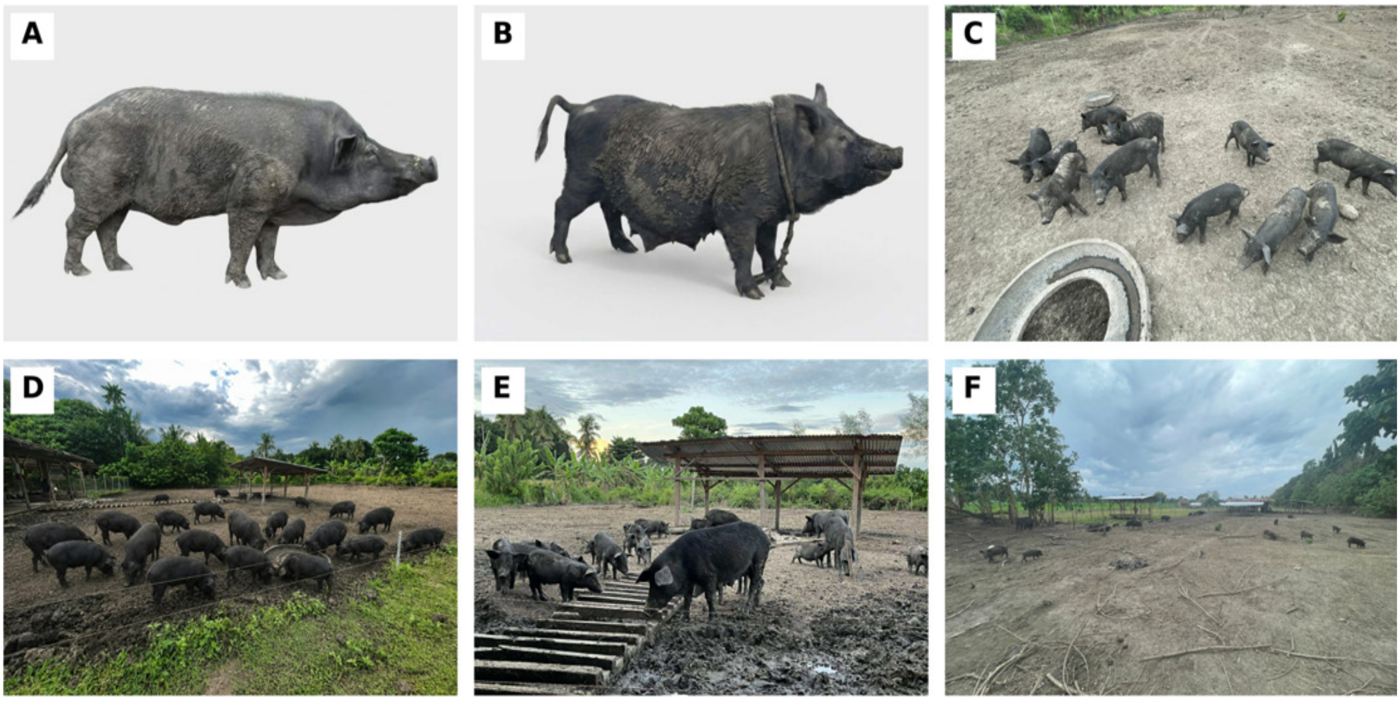

Figure 2: Representative photographs of PNPs and the study site in Alabel, Sarangani Province: (A) adult male; (B) adult female; (C) a group of growing PNPs; (D-F) PNPs and the production conditions at the study site.

Data analysis

All statistical analyses were performed using JASP software (version 0.97.0; JASP Team, 2026). Descriptive statistics were calculated and expressed as mean ± standard deviation (SD) for all growth and morphometric parameters. Data were analyzed using linear mixed models. For body weight and morphometric traits, age and sex were included as fixed effects, while pig identity was included as a random effect to account for repeated measurements from the same animals. For average daily gain (ADG), sex and growth interval were included as fixed effects, while pig identity was included as a random effect. Sow/litter was initially considered as an additional random effect; however, models including sow/litter produced a singular fit, likely due to the small number of sow/litter groups. Therefore, sow/litter was not retained in the final models and was treated as a limitation of the study. Bonferroni-adjusted pairwise contrasts were used for post hoc comparisons. Statistical significance was set at $p < 0.05$.

RESULTS AND DISCUSSION

The body weights and morphometric measurements of PNPs at different stages of growth are presented in Table 1. Linear mixed-model analysis showed that age had a significant effect on body weight and all morphometric traits ($p < 0.01$), indicating that body weight and body measurements increased significantly from birth to 8 months. The individual growth trajectories and corresponding mean trajectories of male and female PNPs are shown in Figures 3 and 4, respectively. These figures show the steady increase in body weight and morphometric traits throughout the study period and also indicate greater variation in body size among pigs as they aged. At birth, the male and female PNPs weighed 1.53 ± 0.54 kg and 1.44 ± 0.41 kg, respectively. Their body weights increased progressively to 43.56 ± 18.44 kg in males and 41.40 ± 17.78 kg in females at 8 months of age, following a sigmoidal or S-shaped growth curve, which is typical for pigs.

Our body weight results are consistent with earlier studies describing PNPs as generally smaller and slower growing than most commercial pig breeds (Avila *et al.*, 2025). Similar findings were reported by Cambangay and Enario (2020) for PNPs raised under semi-intensive production systems. This slow-to-moderate growth is typical of native pigs, which are adapted to challenging production conditions.

Sex had no significant effect on body weight or morphometric traits, indicating that sexual dimorphism was not evident up to 8 months of age under the conditions of the present study. However, because of the small and unequal number of males and females, small to moderate sex-related differences may not have been statistically detectable. When management and environment are the same for both sexes, males and females often grow similarly during early life (Stygar *et al.*, 2017).

Table 1: Body weight and morphometric traits of PNPs in Alabel, Sarangani Province by age and sex

Trait	Age (months)	Male (Mean ± SD)	Female (Mean ± SD)
Body weight (kg)**	0	1.53 ± 0.54^{d}	1.44 ± 0.41^{d}
	3	13.73 ± 3.88^{c}	14.82 ± 4.31^{c}
	6	28.33 ± 10.12^{b}	29.47 ± 11.29^{b}
	8	43.56 ± 18.44^{a}	41.40 ± 17.78^{a}
Shoulder width (cm)**	0	9.11 ± 1.45^{d}	8.60 ± 0.83^{d}
	3	17.78 ± 4.15^{c}	18.87 ± 3.58^{c}
	6	21.78 ± 3.80^{b}	23.00 ± 4.34^{b}
	8	24.56 ± 5.05^{a}	24.60 ± 3.87^{a}
Heart girth (cm)**	0	25.78 ± 3.77^{d}	25.60 ± 2.72^{d}
	3	55.56 ± 7.76^{c}	55.80 ± 7.99^{c}
	6	69.22 ± 9.01^{b}	67.53 ± 9.47^{b}
	8	83.56 ± 15.19^{a}	82.27 ± 13.06^{a}
Midriff girth (cm)**	0	26.78 ± 3.42^{d}	27.53 ± 3.36^{d}
	3	61.33 ± 7.70^{c}	63.87 ± 8.57^{c}
	6	76.00 ± 9.51^{b}	77.60 ± 2.44^{b}
	8	86.78 ± 15.89^{a}	90.47 ± 14.56^{a}
Flank girth (cm)**	0	24.11 ± 3.98^{d}	24.67 ± 5.15^{d}
	3	53.22 ± 7.98^{c}	53.40 ± 7.17^{c}
	6	69.67 ± 14.12^{b}	67.13 ± 13.20^{b}
	8	83.78 ± 16.48^{a}	84.93 ± 18.31^{a}
Body length (cm)**	0	32.44 ± 3.47^{d}	32.93 ± 2.58^{d}
	3	72.56 ± 9.14^{c}	74.33 ± 9.67^{c}
	6	82.00 ± 10.00^{b}	84.53 ± 9.29^{b}
	8	92.44 ± 15.71^{a}	94.33 ± 14.65^{a}
Tail length (cm)**	0	8.00 ± 1.32^{d}	7.67 ± 1.11^{d}
	3	17.44 ± 3.21^{c}	17.40 ± 1.64^{c}
	6	20.44 ± 2.92^{b}	20.73 ± 2.43^{b}
	8	21.89 ± 3.14^{a}	21.93 ± 2.43^{a}

Values are presented as mean ± standard deviation. ** indicates a significant effect of age based on linear mixed-model analysis ($p < 0.01$). Different superscript letters within the same trait indicate significant differences among ages based on Bonferroni-adjusted pairwise contrasts ($p < 0.05$).

Body length increased from approximately 32 cm at birth to over 92-94 cm at 8 months of age, while heart girth increased from approximately 25 cm to more than 82 cm. These changes reflect the substantial body development occurring during the post-weaning and pre-adult growth phases. Other studies have found that body measurements, such as heart girth and body length, are associated with body weight in native pigs. Cambangay and Enario (2020) posited that morphometric traits such as heart girth and body length were associated with body weight in PNPs. In the present study, both body weight and morphometric traits increased with age, reflecting the overall growth and development of the animals. However, correlation and regression analyses were not performed because the present study focused on longitudinal growth and morphometric development rather than the development of body weight prediction equations. Thus, the predictive value of individual morphometric traits, such as heart girth and body length, for estimating body weight could not be evaluated and should be addressed in future studies with larger datasets.

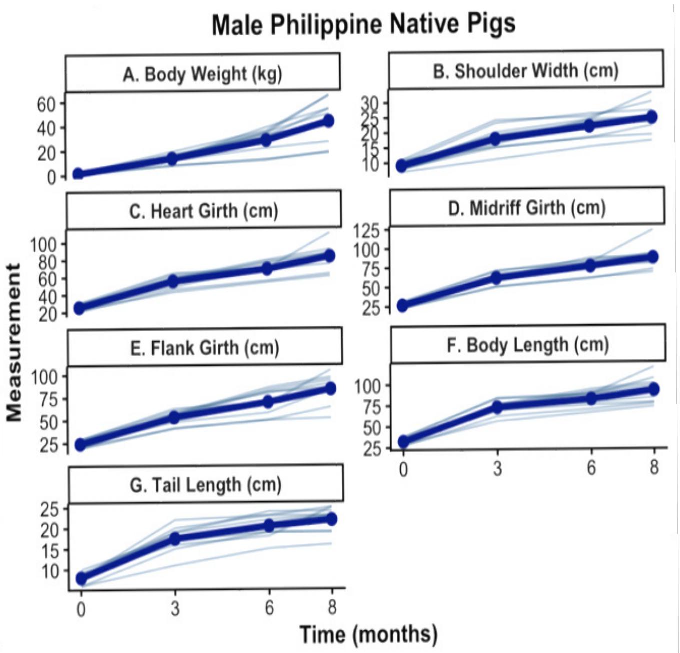

Figure 3: Spaghetti plots showing the growth trajectories of body weight and morphometric traits in male PNPs from 0 to 8 months of age. Thin lines represent individual pigs, while the thick line represents the mean trajectory.

Females had slightly higher values for some traits, such as the midriff girth and body length at later growth stages, suggesting small differences in body shape or fat deposition rather than differences in growth rate. These differences, however, are not statistically significant. Similarly, native pig populations can display morphological variability despite comparable growth performance, likely reflecting underlying genetic diversity within populations (Logronio *et al*., 2022).

Table 2 shows the ADG of male and female PNPs during different growth periods and the overall ADG of PNPs for both sexes. Linear mixed-model analysis showed that sex had no significant effect on ADG ($p = 0.689$), whereas growth interval had a significant effect on ADG ($p= 0.002$). Bonferroni-adjusted pairwise contrasts showed that ADG during the 6-8 month period was significantly higher than ADG during the 0-3- and 3-6-month periods, while ADG did not differ significantly between the 0-3 and 3-6 month periods. The overall ADG was 0.18 ± 0.08 kg/day for males and 0.17 ± 0.07 kg/day for females. The ADG values recorded in the present study are within the range reported for PNPs under various feeding systems. No significant differences in ADG across dietary treatments were observed by Casimiro *et al*. (2022) and Bitao and Gaffud (2024), suggesting that PNPs maintain stable growth rates despite differences in the composition of feeds, indicating a degree of nutritional resilience, allowing PNPs to perform consistently under diverse conditions.

Table 2: Average daily gain of male and female PNPs in Alabel, Sarangani Province across growth periods.

Growth period (months)	Male ADG (kg/day) (Mean ± SD)**	Female ADG (kg/day) (Mean ± SD)**
0-3	0.14 ± 0.04^b	0.15 ± 0.05^b
3-6	0.16 ± 0.08^b	0.16 ± 0.09^b
6-8	0.25 ± 0.17^a	0.20 ± 0.13^a
OVERALL	0.18 ± 0.08	0.17 ± 0.07

Values are presented as mean ± standard deviation. ** indicates a significant effect of growth interval based on linear mixed-model analysis ($p < 0.01$). Different superscript letters indicate significant differences among growth periods based on Bonferroni-adjusted pairwise contrasts ($p < 0.05$). Overall ADG is presented descriptively.

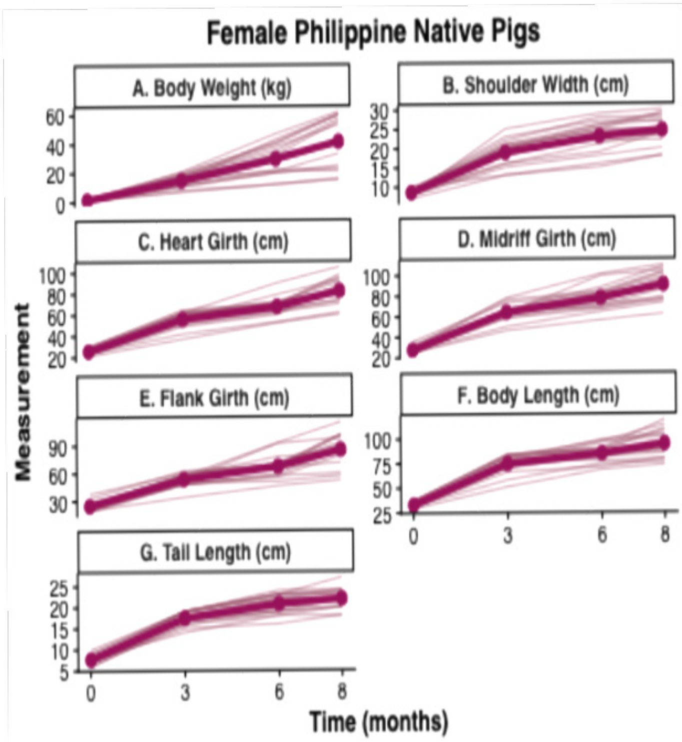

Figure 4: Spaghetti plots showing the growth trajectories of body weight and morphometric traits in female PNPs from 0 to 8 months of age. Thin lines represent individual pigs, while the thick line represents the mean trajectory.

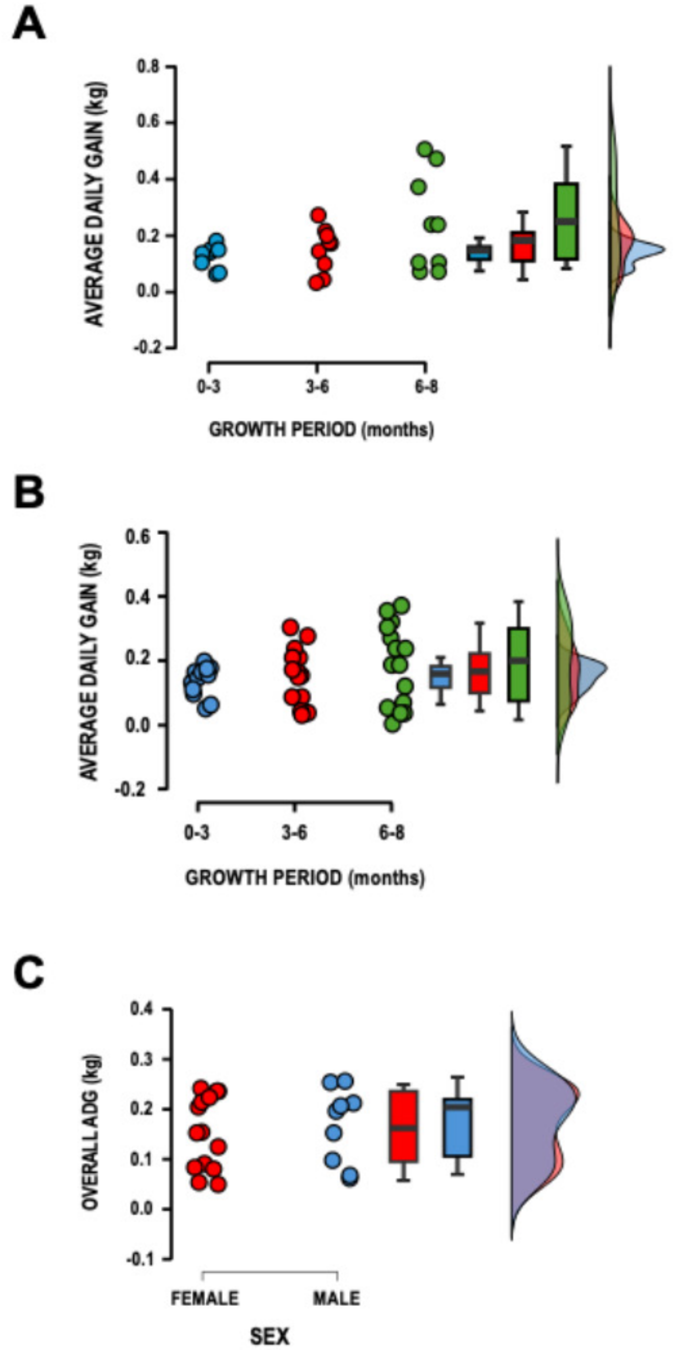

Figure 5: Distribution of ADG values of PNPs in Alabel, Sarangani Province. (A) ADG of male pigs across growth periods; (B) ADG of female pigs across the same growth periods; and (C) overall comparison of ADG between male and female pigs. Points represent individual animals, box plots show the median and interquartile range, and violin plots illustrate the distribution of ADG values.

Figure 5 illustrates the distribution of ADG values for male and female PNPs across growth periods. Descriptively, ADG values showed greater variation during the 6-8 month period, as indicated by the wider spread of observations and broader distribution of values. This pattern suggests possible heterogeneity in individual growth performance at later growth stages. The wider spread of observations during this stage indicates that growth rates became more variable among pigs as they aged. Similar age-related variation in growth performance has been reported in longitudinal studies of pigs, where growth rate patterns changed over time and differed among individuals despite being raised under the same management conditions (van der Heide *et al.*, 2025). This variability may be related to differences in individual genetic background, litter-related effects, feed competition under collective feeding, or variable intake during free grazing. However, these factors were not directly evaluated in the present study and therefore remain unclear.

In the present study, the PNPs were allowed to graze freely within a designated area and were supplemented with locally available feed resources. Native pigs are commonly raised using agricultural by-products, indigenous feed materials, and household food wastes, resulting in moderate but sustained growth (Garcia, 2023). PNPs fed with indigenous feed resources can achieve growth performance comparable to PNPs fed commercial diets, although with greater variability (Bollido, 2024). The steady but variable growth patterns observed in the present study are consistent with these reports.

A limitation of the present study is that formal measurement repeatability was not assessed, and the genetic background of the animals was not verified through molecular analysis or pedigree records. In addition, sow/litter effects could not be reliably included in the final mixed models. Piglets from the same litter may share genetic and maternal environmental influences and may therefore not be fully independent. Although sow/litter was initially tested as a random effect, the model produced a singular fit, likely due to the small number of sow/litter groups and unequal litter sizes. Thus, the results should be interpreted with caution. The pigs in the present study were classified as PNPs based on their phenotypic characteristics; therefore, the possibility of historical introgression from exotic breeds cannot be completely excluded. Future studies incorporating genetic characterization are needed to confirm population identity and evaluate the genetic distinctiveness of native pig populations in Mindanao. Further studies involving larger populations using standardized methodologies across regions are likewise recommended to determine whether native pig populations in Mindanao exhibit distinct growth and morphometric characteristics compared with other PNP populations.

CONCLUSION

Overall, our results show that PNPs grow steadily and develop consistently under semi-intensive management, with no significant differences between males and females up to 8 months of age. We also observed greater variation in growth rates among older pigs but we did not examine the factors that may have caused this variation. This study provides basic growth and body measurement data for PNPs in Mindanao, where such information has been scarce, and may help improve native pig farming in the future. Practically, the results suggest that male and female may be managed similarly during early growth, but farmers should expect slow-to-moderate growth and monitor individual variation. Because the sample size was small, the findings should be treated as a starting point. Future studies should include larger populations from multiple farms across different areas of Mindanao, with measurements taken beyond 8 months of age, preferably up to 12 months, to better evaluate growth patterns, farm-level variation, and possible regional differences.

ACKNOWLEDGEMENT

The authors extend their gratitude to the management of the ACG Native Swine Farm for granting permission to collect data throughout the study period.

NOVELTY STATEMENT

This paper represents the first investigation of the longitudinal growth patterns of PNPs in Mindanao, Philippines. Previous studies on PNPs have primarily been conducted in Luzon and the Visayas, with no available studies from Mindanao. The study also provides baseline growth and morphometric data that may support future genetic characterization, conservation efforts, and native pig development programs in the region.

AUTHOR'S CONTRIBUTION

AJA performed the experiment, collected the data, and assisted in manuscript preparation. JEO led the study conceptualization and prepared the manuscript. FAS, MGC, AM, and ARA contributed to the study's conceptualization.

Generative AI and AI-assisted technology statement

AI-assisted tools were used solely for language refinement and to improve clarity and readability, particularly during the revision process. All scientific content, analyses, interpretations, and conclusions were developed, reviewed, and approved by the authors.

Conflict of interest

The authors have declared no conflict of interest.

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