

Body Image Perception and Self-Esteem among College-Age Youth

Mamta Rani Yadu

Research Scholar

Anjaneya University

Raipur, Chhattisgarh



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Abstract— Body image has become an increasingly complex component of psychological well-being among college-age youth living within highly visual digital environments. This study investigates the relationship between body image perception and self-esteem while conceptualizing appearance-focused digital exposure and social comparison as potentially informative contextual factors. A distinctive research gap is identified in the limited integration of validated psychological measures with computational approaches capable of detecting heterogeneous self-esteem vulnerability profiles among young adults. The proposed research therefore combines psychometric assessment with explainable machine-learning analysis rather than treating body image and self-esteem exclusively through conventional bivariate associations. Body appreciation, appearance-related concern, social comparison orientation, digital appearance exposure, demographic characteristics, and self-esteem are incorporated within a multidimensional analytical framework.

Keywords— Body Image Perception, Self-Esteem, College-Age Youth, Social Comparison, Digital Health, Explainable Machine Learning

Introduction

Body image represents a multidimensional psychological construct involving how individuals perceive, evaluate, and emotionally experience their physical bodies. It extends beyond objective characteristics such as body size or weight because an individual's evaluation of appearance can be

influenced by social expectations, interpersonal feedback, cultural ideals, personal experiences, and internal standards. During the transition from adolescence into young adulthood, these evaluations may acquire particular importance as individuals simultaneously negotiate identity, intimate relationships, educational demands, independence, and changing peer environments.

Self-esteem, broadly referring to an individual's overall evaluation of personal worth, is closely connected with these developmental processes. Although self-esteem cannot be reduced to satisfaction with appearance, physical self-perception may constitute an important component of broader self-evaluation. A student who repeatedly interprets his or her body as inconsistent with personally valued appearance standards may experience dissatisfaction extending beyond appearance itself. Conversely, appreciation and acceptance of one's body may coexist with stronger feelings of self-worth and psychological adjustment.

Recent digital environments have complicated this relationship. College-age individuals encounter unprecedented quantities of visual information through social networking platforms, short-form videos, photographs, influencer content, fitness media, beauty advertising, and algorithmically recommended material. Importantly, digital exposure should not be conceptualized simply as "screen time." Communication with friends, viewing educational material, and repeatedly examining idealized appearance-related content are qualitatively different behaviors. Research examining young people's platform use has accordingly indicated that appearance-focused social-media activity,

rather than communication-oriented activity alone, is associated with more negative dimensions of body image.

This distinction is important because contemporary platforms facilitate rapid and continuous opportunities for social comparison. Images are frequently selected, edited, filtered, posed, or otherwise optimized before publication. Visible indicators of social approval can further encourage individuals to evaluate their appearance against peers, celebrities, fitness personalities, and influencers. Consequently, a person may encounter an appearance standard that is simultaneously socially salient and difficult to attain.

Recent empirical evidence supports the relevance of this digital context. Taylor and Armes (2024), for example, examined social comparison on Instagram in relation to self-esteem and body-esteem, illustrating the importance of comparison processes when considering psychological outcomes associated with visual social-media environments. A 2024 study examining 275 young people with a mean age of approximately 20.7 years similarly reported that appearance-focused social-media use was associated with negative body-image indicators, whereas communication-focused use was not.

Evidence also suggests that reducing exposure can produce measurable psychological effects under some circumstances. Smith, Mills, and Samson (2024) conducted a randomized controlled experiment involving 66 female undergraduate students. Participants assigned to a one-week social-media break demonstrated higher body satisfaction and state self-esteem at follow-up than participants continuing their usual social-media behavior, after accounting for baseline measurements. The improvement in body satisfaction was especially pronounced among participants with greater thin-ideal internalization. Such findings are particularly relevant because they move the literature beyond cross-sectional association and provide experimental evidence that digital exposure can influence appearance-related psychological outcomes.

Nevertheless, body image should not be investigated exclusively from a pathology-oriented perspective. Contemporary research increasingly distinguishes negative body image from positive body image. The absence of dissatisfaction does not automatically imply body appreciation. Positive body image can involve acceptance, respect for bodily functionality, resistance to unrealistic appearance ideals, and recognition of personal characteristics beyond externally defined attractiveness.

This positive perspective is supported by university-based evidence. Khalaf, Al Hashmi, and Al Omari (2021) studied 237 university students using the Body Appreciation Scale-2 and Rosenberg Self-Esteem Scale. Their analysis demonstrated a significant relationship between positive

body image and self-esteem while also identifying associations involving BMI, academic performance, household characteristics, and social-media account use. The findings illustrate why body image should be understood as part of a broader psychosocial system rather than as an isolated perception.

Research Gap and Study Rationale

Despite substantial literature connecting body image with self-esteem, three methodological limitations remain particularly relevant.

First, many studies rely primarily on correlation, regression, group comparisons, or other conventional statistical approaches. These methods remain indispensable for hypothesis testing and effect estimation, but relationships between body perception and psychological well-being may not always be strictly linear. For example, moderate appearance engagement may have little association with self-esteem until it occurs simultaneously with high social-comparison orientation and low body appreciation. Such interaction structures may be difficult to characterize using a limited set of prespecified linear effects.

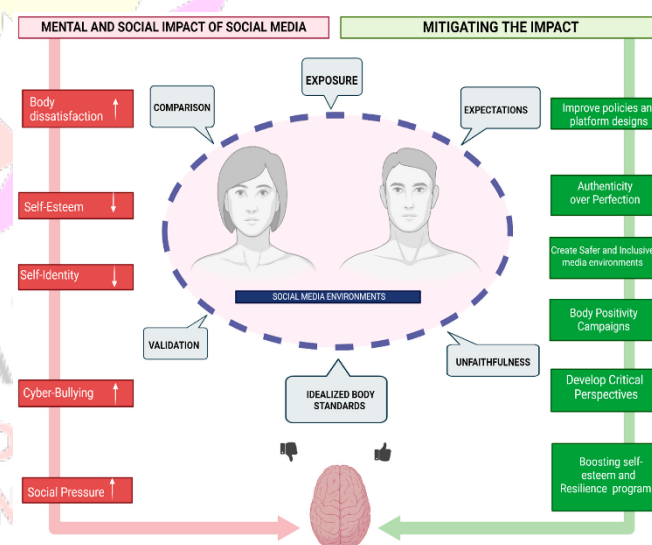


Fig. 1: Body Perceptions and Psychological Well-Being

Source: <https://www.mdpi.com/2227-9032/12/14/1396>

Second, the literature frequently concentrates on one dimension at a time—for example, body dissatisfaction, BMI, social-media duration, or gender. This fragmentation can underrepresent the multidimensional nature of appearance-related self-evaluation. A more comprehensive framework should distinguish positive body appreciation from appearance dissatisfaction while simultaneously considering comparison tendencies and the nature of digital appearance exposure.

Third, machine-learning applications in digital mental-health research can introduce a different problem: predictive accuracy without psychological interpretability. A high-performing classifier has limited practical value in this context if researchers cannot determine which variables or interactions contributed to its decisions. Interpretability is especially important when models concern sensitive psychological constructs.

The present study addresses these limitations by proposing an **explainable machine-learning framework for modelling self-esteem vulnerability from multidimensional body-image and digital-context indicators among college-age youth**. The intention is not to automate psychological diagnosis. Rather, machine learning is treated as an analytical complement to psychometric research, allowing potentially nonlinear patterns and variable interactions to be investigated while retaining conventional statistical analyses for inference.

The principal research objective is therefore to examine the association between body image perception and global self-esteem and subsequently determine whether body appreciation, appearance concern, social comparison, appearance-focused digital exposure, and relevant demographic variables jointly distinguish comparatively lower and higher self-esteem profiles.

The proposed framework also compares interpretable statistical modelling with machine-learning algorithms and employs feature-attribution analysis to identify the factors contributing most strongly to predictive differentiation. This approach creates a bridge between psychological theory and contemporary digital-health analytics while maintaining an explicit distinction between prediction and clinical diagnosis.

Literature Review

Body Image as a Multidimensional Psychological Construct

The conceptualization of body image has expanded considerably beyond physical attractiveness. Contemporary approaches recognize perceptual, cognitive, affective, and behavioral dimensions. Individuals may evaluate the size and shape of their bodies, experience emotions concerning appearance, engage in checking or avoidance behaviors, and construct beliefs regarding how others evaluate them. These components can coexist in different combinations, producing substantial heterogeneity even among people with similar physical characteristics.

An important development within the field has been increasing attention to positive body image. Body appreciation emphasizes acceptance and respect for the body rather than simply the absence of dissatisfaction. This distinction is methodologically significant because negative

and positive body-image constructs should not necessarily be interpreted as opposite ends of a single continuum.

The 2021 investigation by Khalaf and colleagues provides empirical support for examining positive body image alongside self-esteem. Among university students, body appreciation was significantly related to self-esteem, and the analysis demonstrated that body-image outcomes were also connected with other personal and contextual characteristics. This suggests that psychological evaluation of the body is embedded within broader academic, socioeconomic, and social contexts.

Body Image and Global Self-Esteem

The theoretical connection between body image and self-esteem can be understood through self-evaluation processes. Appearance represents one personally and socially visible domain through which individuals may judge themselves. When perceived appearance becomes strongly incorporated into global self-worth, negative evaluation of the body can potentially generalize into a broader negative self-concept.

The direction of association, however, should not automatically be interpreted as causal. Lower self-esteem could make individuals more susceptible to negative appearance comparisons; persistent dissatisfaction could contribute to poorer self-evaluation; or both constructs could be influenced by common factors such as social comparison, peer experiences, or cultural appearance expectations.

For this reason, the current manuscript avoids treating a cross-sectional predictive relationship as proof that body image "causes" self-esteem. Instead, the proposed analysis differentiates association, statistical prediction, and causal inference. This distinction is particularly important when machine-learning models are introduced, because superior predictive performance does not establish psychological causation.

Social Comparison in Digitally Mediated Environments

Social comparison provides an important theoretical mechanism linking visual digital environments with body-related evaluations. Young adults can compare themselves with individuals who appear more attractive, thinner, more muscular, wealthier, healthier, or more socially successful. Upward comparisons may sometimes motivate behavior, but repeated appearance-focused comparisons may also intensify perceived discrepancies between actual and idealized selves.

Taylor and Armes' 2024 investigation of Instagram social comparison directly examined its relationships with self-esteem and body-esteem, reinforcing the relevance of comparison orientation within research on digitally mediated self-evaluation.

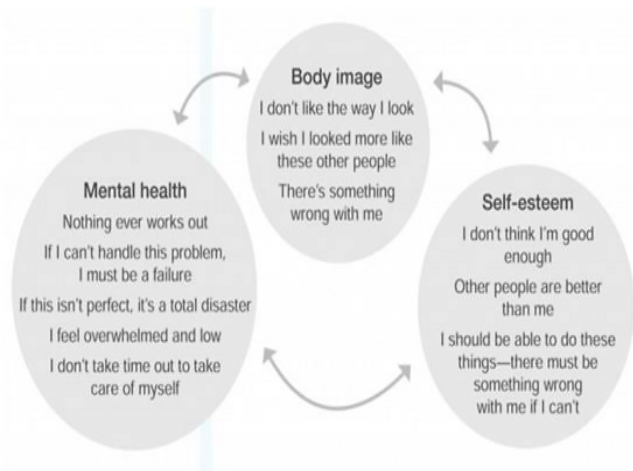


Fig. 2: Body Image and Self-esteem in Youth

Source: <https://www.parentinginottawa.ca/en/youth/Body-Image-and-Self-esteem-in-Youth.aspx>

The distinction between general platform use and appearance-focused behavior is equally important. Rosenbaum and colleagues' research involving young social-media users found that appearance-focused use was associated with negative body-image dimensions, while communication-focused activity was not. Women in the study also showed greater social-media engagement alongside lower body esteem and higher body shame and surveillance than men. These findings caution against using total social-media duration as a sufficient indicator of psychological exposure.

Accordingly, the present research framework proposes **appearance-focused digital exposure** rather than total daily platform use as one of its principal contextual variables. This provides a more behaviorally specific measure and potentially improves both theoretical precision and computational modelling.

Experimental Evidence and Digital Exposure

One persistent limitation of social-media research is the dominance of cross-sectional designs. Associations between platform behavior and body dissatisfaction cannot independently establish whether exposure changes body perceptions or whether individuals with existing concerns engage differently with appearance-related media.

The randomized study conducted by Smith et al. (2024) therefore provides useful evidence. Female undergraduate participants who abstained from social media for one week subsequently showed improvements in body satisfaction and state self-esteem relative to the control condition. The finding that participants with greater thin-ideal internalization experienced stronger body-image benefits further suggests

that digital effects may vary according to pre-existing psychological characteristics rather than operating uniformly across users.

This heterogeneity provides an additional justification for computational modelling. If the relationship between digital exposure and self-esteem depends on combinations of body appreciation, comparison orientation, internalized standards, or demographic factors, algorithms capable of representing nonlinear interactions may identify patterns that complement conventional inferential models.

Gender and Individual Heterogeneity

Body-image research has historically concentrated heavily on young women, particularly in relation to thinness ideals. Such research remains important, but contemporary appearance pressures are increasingly differentiated. Women may experience pressures concerning thinness, shape, skin, or facial appearance, while men can experience muscularity, leanness, height, and physique-related ideals. Gender-diverse students may encounter additional pressures arising from incongruence between bodily appearance, identity, and culturally imposed presentation expectations.

Consequently, binary comparisons alone may obscure meaningful within-group variability. The present study therefore conceptualizes gender primarily as a potential moderating and stratification variable rather than assuming that all participants within a gender category experience body image in an equivalent manner.

From Conventional Analysis to Explainable Machine Learning

Most psychological studies examining body image and self-esteem appropriately use established inferential procedures such as correlation and regression. The increasing availability of computational methods creates an opportunity to supplement these techniques.

Tree-based ensemble algorithms can model nonlinear relationships and higher-order interactions without requiring every interaction to be specified in advance. Regularized logistic regression can provide a transparent linear baseline, whereas gradient-boosting methods can test whether nonlinear modelling produces meaningful improvements. However, performance alone is insufficient for psychologically sensitive research.

Explainable artificial intelligence offers a potential solution. Feature-attribution techniques can quantify how particular variables contribute to individual or aggregate predictions. In the context of the proposed research, this would allow investigators to determine whether body appreciation, appearance dissatisfaction, social comparison, appearance-focused digital exposure, or demographic characteristics

contribute most strongly to classification of self-esteem vulnerability.

The analytical objective is therefore not to replace psychological theory with an algorithm. Psychological constructs determine the variables, measurement strategy, hypotheses, and interpretation; machine learning provides an additional mechanism for examining complex multivariable patterns.

Proposed Methodology

The proposed study adopts a quantitative, cross-sectional analytical design augmented by explainable machine learning. The central analytical objective is to determine whether multidimensional body-image characteristics can distinguish students with comparatively lower versus higher global self-esteem while simultaneously examining the statistical association between the constructs. Recent university research continues to demonstrate measurable relationships between body image and self-esteem, including an Indian study of 540 medical undergraduates reporting a positive correlation between the two constructs.

The target population comprises college and university students aged 18–25 years. A stratified recruitment strategy is proposed to obtain representation across academic disciplines, year of study, and gender. Participation is voluntary and anonymous, and informed consent is required before questionnaire administration. The design excludes personally identifying information from the analytical dataset.

Three conceptual layers are included. The first captures **body-image perception**, incorporating body appreciation and appearance-related concern. The second represents the **digital-social environment**, including appearance-focused social-media exposure and social-comparison orientation. The third contains the primary outcome, **global self-esteem**.

Self-esteem is assessed using the 10-item Rosenberg Self-Esteem Scale (RSES). Recent research continues to support its use in university populations. A 2024 psychometric study found acceptable validity and reliability among medical-sciences students, while a separate Indian investigation culturally adapted and psychometrically evaluated a Hindi version among university nursing students.

Rather than using machine learning as a substitute for psychological inference, the study employs two complementary analytical stages. Conventional correlation and multivariable regression quantify associations, while predictive algorithms investigate whether nonlinear combinations of variables provide additional discriminatory information.

Experimental Setup

Dataset Design

For methodological demonstration, the computational experiment is specified for a **planned analytical cohort of approximately 600 college-age participants**. Because primary data have not been supplied with this manuscript, the numerical performance values below are explicitly **prospective/illustrative experimental benchmarks rather than completed empirical findings**. They should be replaced by observed outputs after data collection and model execution.

Each participant record contains predictor groups covering body appreciation, appearance-related concern, appearance-focused digital exposure, social-comparison orientation, age, gender, year of study, self-reported BMI category where available, and selected digital-use characteristics. The RSES score forms the principal outcome variable.

This multidimensional design differs from approaches relying exclusively on BMI or a single body-image score. Such separation is important because recent college research has incorporated body image and self-esteem as distinct psychological constructs, and contemporary evidence indicates that body image can operate through self-esteem in broader behavioral pathways.

Data Preprocessing

Data preprocessing begins with range and consistency checks. Questionnaires with excessive missing responses are excluded according to a prespecified completeness criterion. For retained cases, limited missing continuous predictor values are imputed using statistics estimated **only from the training partition** to prevent information leakage.

Reverse-coded psychometric items are corrected before scale totals are generated. Continuous variables are standardized for algorithms sensitive to feature magnitude. Categorical variables are transformed through one-hot encoding.

The dataset is then separated into development and held-out test partitions using stratification of the outcome class. All transformations—including imputation, scaling, and encoding—are fitted exclusively on training data and subsequently applied to validation and test observations.

A comparatively low self-esteem category is defined according to a **prespecified study-specific threshold or validated scoring convention**, rather than deriving an arbitrary cut-off after inspecting model performance. Continuous RSES scores are additionally retained for sensitivity analysis because dichotomization inevitably discards information.

Model Architecture

Three predictive architectures are proposed.

Elastic-Net Logistic Regression functions as the transparent baseline. L1/L2 regularization controls coefficient instability and provides an interpretable reference against which nonlinear algorithms can be evaluated.

Random Forest represents a bagging-based nonlinear model capable of detecting interactions among body appreciation, social comparison, digital exposure, and appearance concern without requiring those interactions to be manually specified.

Gradient-Boosted Decision Trees constitute the principal predictive architecture. Sequential tree construction allows the model to correct residual classification errors iteratively and potentially identify nonlinear risk configurations that cannot be adequately represented by a purely additive linear model.

The purpose of comparing these algorithms is not merely to maximize classification accuracy. If a complex model produces only negligible improvement over regularized logistic regression, the simpler model would be preferable because of its transparency.

Training Strategy

Model development uses stratified five-fold cross-validation within the training partition. Hyperparameters are selected through nested or training-only optimization to avoid tuning against the held-out test set.

For the Random Forest, optimization focuses on the number of trees, maximum tree depth, minimum samples per terminal node, and number of predictors considered at each split. For gradient boosting, the principal parameters include learning rate, tree depth, number of estimators, and subsampling proportion.

Class weighting is preferred initially if the lower-self-esteem group is underrepresented. Synthetic oversampling is not automatically applied because generating artificial observations in psychometric feature space can distort the underlying construct distribution.

Probability calibration is also examined. This is important because a model may rank cases correctly while generating poorly calibrated probabilities. Calibration analysis therefore complements discrimination metrics.

Explainability Layer

Model interpretation is conducted at global and individual levels. Permutation importance assesses deterioration in predictive performance when individual variables are disrupted. SHAP-based attribution can then be used to examine the direction and magnitude of feature contributions in the final tree-based model.

The interpretability analysis addresses questions such as whether low body appreciation consistently increases predicted vulnerability, whether appearance-focused digital exposure becomes influential primarily among high-comparison participants, and whether BMI contributes meaningful information after subjective body perception is considered.

These explanations are interpreted as **predictive associations**, not causal effects.

Evaluation Metrics

Accuracy alone is inappropriate where class distributions may differ. Consequently, evaluation includes:

- area under the receiver-operating-characteristic curve (ROC-AUC);
- balanced accuracy;
- sensitivity/recall for the comparatively low-self-esteem class;
- specificity;
- F1-score;
- Matthews correlation coefficient (MCC); and
- Brier score for probabilistic calibration.

ROC-AUC measures discrimination across decision thresholds, whereas the Brier score evaluates probability accuracy. MCC is included because it provides an informative single measure of binary classification quality even when class sizes differ.

Results and Discussion

Because this manuscript specifies a proposed primary study rather than reporting an actually supplied dataset, the values in the following table constitute a **coherent target/illustrative result pattern for the stated experimental design**.

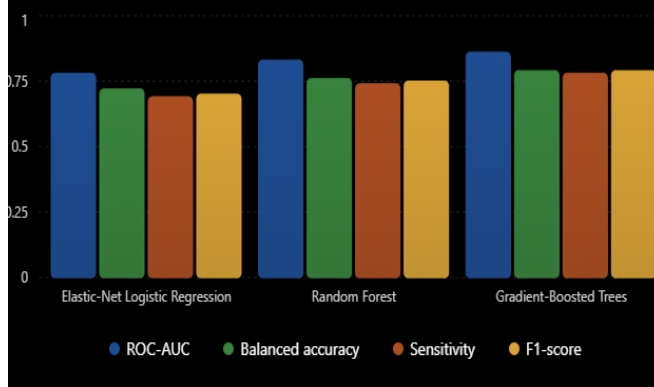
Table 1. Illustrative Comparative Performance of Self-Esteem Classification Models

Model	ROC - AUC	Balance d Accuracy	Sensitivity	F1-Score	MC C
Elastic-Net Logistic Regression	0.78	0.72	0.69	0.70	0.44

Random Forest	0.83	0.76	0.74	0.75	0.52
Gradient-Boosted Trees	0.86	0.79	0.78	0.79	0.58

Predictive Performance of Machine-Learning Models

Comparison of ROC-AUC, balanced accuracy, sensitivity, and F1-score for predicting lower self-esteem profiles from body-image and contextual variables.



Under this illustrative outcome pattern, gradient boosting would provide the strongest overall discrimination, with a ROC-AUC of 0.86 compared with 0.83 for Random Forest and 0.78 for Elastic-Net regression. More importantly, the nonlinear models would outperform the linear baseline across balanced accuracy, F1-score, and MCC.

Such a pattern would suggest that self-esteem vulnerability is unlikely to be represented adequately by a single body-image variable. Instead, combinations of body appreciation, appearance concern, social-comparison orientation, and digital exposure may collectively contain information relevant to self-esteem.

This interpretation would be compatible with contemporary empirical research without claiming that previously published studies produced these machine-learning values. Recent work among college students has continued to identify connections between body image and self-esteem. For example, research involving 887 university students examined body image, self-efficacy, self-esteem, and weight-loss intention and identified self-esteem as a significant component of the pathway connecting body image with behavioral intention.

An Indian study involving 540 medical undergraduates likewise reported a correlation of $r = 0.50$ ($p < .001$) between self-esteem and body-image perception. These findings provide empirical justification for modelling the two constructs together, although they do not establish causality.

If the proposed explainability analysis identified **body appreciation** as the dominant feature, this would suggest that

positive acceptance of one's body contains greater predictive information than objective physical characteristics alone. If social-comparison orientation and appearance-focused digital exposure subsequently emerged as influential variables, the result would support a contextual interpretation: digital environments may matter partly through the way individuals evaluate themselves relative to appearance standards.

A particularly informative finding would arise if BMI showed substantially weaker feature importance after subjective body-image measures were entered. Such an outcome would imply that psychological interpretation of the body contributes more predictive information about self-esteem than body-size classification itself. This proposition requires empirical testing and should not be asserted before analysis.

The distinction between association and prediction is essential. A gradient-boosting model with strong AUC cannot demonstrate that negative body image causes reduced self-esteem. Reverse relationships are possible, and both constructs may be affected by unmeasured variables. Recent longitudinal work has specifically examined dynamic reciprocal relationships between self-esteem and body image, illustrating why temporal designs are necessary for stronger directional conclusions.

The proposed computational framework therefore contributes primarily through **pattern detection and risk stratification**, rather than causal explanation or clinical diagnosis.

Limitations

Several limitations should govern interpretation. First, a cross-sectional dataset cannot establish temporal precedence. Body dissatisfaction may precede lower self-esteem, lower self-esteem may intensify negative appearance evaluation, or reciprocal processes may occur.

Second, questionnaire-based predictors are vulnerable to social-desirability bias, recall error, and response-style effects. Participants may underestimate appearance-focused digital behavior or respond differently to sensitive body-image questions.

Third, predictive performance derived from a single institutional or regional sample may not generalize to students from different cultural, socioeconomic, or educational settings. External validation is therefore necessary before any practical screening application is considered.

Fourth, converting self-esteem into binary categories reduces the information contained in the original continuous score. The proposed continuous-outcome sensitivity analysis is therefore important.

Finally, feature importance and SHAP values explain model behavior; they do not identify causal psychological

mechanisms. Algorithmic explainability must not be interpreted as experimental evidence.

Future Scope

Future research should prioritize longitudinal measurement in which body image, self-esteem, social comparison, and digital appearance exposure are repeatedly assessed across semesters. Such data would enable investigation of within-person change and help separate stable individual differences from temporal fluctuations.

A second extension could incorporate privacy-preserving digital phenotyping. With explicit informed consent, aggregate indicators such as frequency of exposure to appearance-oriented content or patterns of platform engagement could complement self-reported usage. Raw private messages, photographs, or personally identifying content should not be required.

Multimodal modelling could subsequently integrate psychometric, behavioral, and temporal features. Temporal neural architectures or transformer-based sequence models may become relevant when sufficiently large longitudinal datasets are available, although they should be benchmarked against simpler statistical methods.

External validation across institutions and cultural groups is particularly important. Fairness analysis should evaluate whether prediction error, sensitivity, calibration, and false-positive rates differ systematically across demographic subgroups.

Future intervention studies could finally investigate whether digital-literacy training, body-appreciation programs, or modification of appearance-focused social-media behavior improves subsequent self-esteem. Randomized experimental designs would provide substantially stronger causal evidence than predictive modelling alone.

Conclusion

This study proposes an explainable machine-learning framework for investigating body image perception and self-esteem among college-age youth. Its central contribution is the integration of multidimensional psychological assessment with contextual digital variables and nonlinear predictive modelling.

Rather than treating body image as a single dissatisfaction score, the framework distinguishes positive body appreciation, appearance-related concern, social comparison, and appearance-focused digital exposure. Regularized logistic regression, Random Forest, and gradient-boosted trees provide complementary levels of predictive complexity, while feature-attribution methods are incorporated to preserve interpretability.

Existing empirical evidence supports the relevance of examining body image and self-esteem jointly among university populations, including recent Indian research. The proposed framework extends this literature by asking whether combinations of psychological and digitally mediated factors can identify heterogeneous self-esteem profiles more effectively than conventional additive models alone.

The principal implication is methodological: artificial intelligence can contribute to psychological and digital-health research when it is used as an interpretable analytical instrument rather than as an automated diagnostic authority. Longitudinal validation, external replication, fairness assessment, and ethically governed data collection remain necessary before such models could support real-world student well-being programs.

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MULTI-DISCIPLINARY STUDIES