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Review

The Role of Plant-Forward Diets in Physical Attractiveness: Integrating Facial, Olfactory, and Morphological Signals for Health Behavior Change

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Abstract

Traditional public health messaging prioritizes disease prevention, whereas individual motivations for dietary change frequently focus on appearance and social outcomes. Physical attractiveness functions as a multimodal signal, combining facial appearance, body odor, and body composition. Evolutionary models posit that such cues communicate fitness-relevant information regarding health status. This narrative review integrates empirical evidence linking plant-forward dietary patterns to facial attractiveness, body odor quality, and adiposity. It examines the mechanisms underlying these associations and their implications for health promotion strategies. Literature searches identified peer-reviewed articles published between 2000 and 2025 that investigated relationships between dietary patterns and appearance-related outcomes, including facial attractiveness, skin coloration, body odor, and body composition in adult populations. Evidence from experimental, observational, and cross-cultural research indicates that diet influences attractiveness through multiple pathways. Increased intake of carotenoid-rich fruits and vegetables enhances facial skin coloration and perceived health within weeks. Glycemic load impacts attractiveness through mechanisms such as perceived age and sexual dimorphism. Dietary composition affects body odor pleasantness by altering sweat chemistry and microbial metabolism. Plant-based dietary

patterns support achieving adiposity levels associated with peak attractiveness. These modalities operate on distinct temporal scales and provide partially independent information, consistent with multiple-message models of sexual signaling. Diet is a modifiable determinant of socially salient appearance cues. Appearance-based feedback has been hypothesized to promote dietary behavior change by delivering prompt and personally relevant reinforcement, though this pathway requires further empirical evaluation. Presenting dietary recommendations in terms of visible outcomes may complement traditional health messaging by aligning individual motivations with public health objectives.

Keywords
Interpersonal attraction; physical appearance; body odor; adiposity; skin pigmentation; carotenoids; health promotion; diet; plant-based diet

1. Introduction

Traditional public health messaging emphasizes disease prevention and longevity, yet personal motivations for dietary change often center on appearance and social outcomes [1-3]. Physical traits can serve as indicators of health, reproductive potential, and genetics, particularly when direct observation of physiological traits is not possible [4, 5]. While perceptions of physical attractiveness are inherently subjective and shaped by individual, cultural, and contextual factors, research suggests that certain physical characteristics are broadly perceived as attractive across populations, likely reflecting evolutionary pressures related to health, fertility, and survival rather than universal standards of beauty. In support of this, evolutionary models of sexual selection indicate that humans derive fitness-relevant information from appearance cues such as facial skin quality, coloration, and age-related features [5, 6]. Facial appearance and skin-aging features are linked to underlying immune function, oxidative stress, and nutritional status, while perceived age is a predictor of mortality risk [4, 7, 8]. Among these characteristics, carotenoid-based skin coloration acts as an "honest signal" of health because carotenoids cannot be synthesized by the body and must be obtained through dietary intake, primarily from fruits and vegetables [8-11].

In addition to visual cues, body odor serves as an individually distinctive and partially heritable signal influenced by immune activation and cellular metabolism [12, 13]. Axillary odor has been associated with mate preferences and intrasexual competition, and experimentally induced illness consistently reduces its perceived pleasantness [5, 13, 14]. Diet is a significant non-genetic factor influencing variation in body odor, with even short-term dietary changes producing noticeable effects [12, 15]. Facial coloration and body odor together constitute dynamic, condition-sensitive signals that can respond rapidly to biological changes, rendering them particularly relevant for health promotion strategies designed to impact dietary behavior [1, 12, 16].

Beyond these surface characteristics of facial appearance and scent, body composition represents a third core element of physical attractiveness [17, 18]. Adiposity influences perceptions of health and functional capacity, and is closely associated with potential for survival and reproductive outcomes [17, 18]. While morphological ratios, such as the shoulder-to-waist ratio, contribute to assessments of male attractiveness, adiposity provides substantial biologically

relevant information throughout different populations [18-24]. Diet functions as a central pathway through which facial coloration, body odor, and adiposity can be simultaneously affected [12, 13, 17]. Plant-forward dietary patterns, which emphasize whole plant foods while reducing but not necessarily eliminating animal products (and thus are distinct from strictly vegetarian or vegan diets), are particularly important in this context because they influence carotenoid intake, metabolic by-products that affect scent, and energy balance [10, 12, 25-27]. Framing dietary change in terms of visible and socially meaningful outcomes, such as attractiveness, may therefore complement traditional health messaging by aligning personal motivations with public health aims [1, 3, 6].

2. Materials and Methods

A narrative review was conducted to synthesize empirical evidence connecting plant-forward dietary patterns to facial appearance, body odor, and body mass. Literature searches were performed using PubMed, Google Scholar, and Web of Science to identify peer-reviewed articles published between January 2000 and December 2025. Search terms included combinations of “diet”, “nutrition”, “attraction”, “physical attractiveness”, “facial attractiveness”, “mate preference”, “sexual selection”, “skin coloration”, “body odor”, “axillary odor”, “sweat”, “body mass index”, “adiposity”, “plant-based diet”, “vegetarian diet”, “vegan diet”, and “health promotion”.

Eligible publications comprised experimental and observational studies (cross-sectional and longitudinal), systematic reviews, meta-analyses, and narrative reviews that examined associations between dietary patterns or specific dietary components and at least one of the following outcomes: (1) facial attractiveness or appearance, including skin coloration, perceived age, and sexual dimorphism; (2) body odor quality or pleasantness; or (3) body composition measures related to physical attractiveness, particularly body mass index and body fat percentage. Included studies were required to involve adult human participants and to use objective or validated subjective assessment methods for appearance-related outcomes. Studies were excluded if they focused solely on dietary supplementation without whole-food interventions (unless the supplementation study was used to isolate a specific biological mechanism directly relevant to interpreting whole-food dietary effects); involved pediatric populations; included clinical populations with metabolic or dermatological conditions that could confound diet-appearance relationships, or used non-comparative designs lacking relevance to the primary research questions.

Additional literature was identified by manually searching reference lists of retrieved articles and relevant reviews in evolutionary psychology, sensory science, and public health nutrition. Priority was assigned to studies using controlled experimental designs, objective measurement tools such as spectrophotometry skin pigmentation assessment, standardized perceptual rating protocols, and statistical methods that accounted for multiple confounders.

Relevant data were extracted and synthesized thematically according to three primary pathways by which diet may influence attractiveness: facial appearance (with emphasis on carotenoid-derived skin coloration and glycemic load effects), olfactory signals (body odor quality and its association with dietary composition), and body composition (adiposity and its contribution to physical attractiveness). For each pathway, evidence was organized by study design, population characteristics, measurement methods, reported effect sizes, underlying biological mechanisms, and limitations. Cross-modal relationships among facial, olfactory, and morphological cues were

evaluated separately to determine the degree of independence or congruence across sensory modalities.

The review focused on identifying consistencies among studies, and additionally noting differences in methodology, conflicting findings, and gaps in the current evidence base. Due to the narrative methodology, formal risk-of-bias assessment and meta-analytic procedures were not performed. Instead, the synthesis prioritized convergent evidence from diverse study designs and populations, with particular emphasis on experimental studies that establish causal relationships and cross-cultural research that demonstrates the generalizability of findings. Across the three primary pathways, the review incorporated approximately 15 studies on carotenoid-based skin coloration and facial attractiveness, 4 studies on glycemic load and facial appearance, 6 studies on diet and body odor, and 8 studies on adiposity, dietary patterns, and attractiveness-related body composition outcomes, with additional sources drawn from the multimodal synthesis and behavioral intervention literatures. Initial searches returned several hundred candidate records per pathway; after applying eligibility criteria, priority was given to studies with the strongest methodological quality and most direct relevance to the primary research questions. It should be acknowledged that, as with all narrative reviews, the selection process carries a risk of confirmation bias toward studies supporting the primary hypotheses. The absence of a formal PRISMA flow diagram and pre-registered inclusion criteria is a limitation of the present work, and conclusions should be interpreted accordingly. The translational relevance of diet-appearance relationships for health promotion and behavioral interventions was evaluated based on the magnitude and rapidity of observed effects, as well as preliminary evidence from appearance-based dietary interventions.

3. Facial Attractiveness as a Diet-Sensitive Signal

Facial attractiveness is evaluated based on several visual cues, including symmetry, averageness, sexual dimorphism, and skin appearance [28-30]. Experimental, observational, and cross-cultural research shows that habitual diet influences attractiveness through multiple biological pathways [12, 15, 17, 31, 32]. Diets rich in carotenoids improve perceived health and attractiveness primarily by altering skin coloration. At the same time, dietary patterns high in glycemic load and refined carbohydrates affect attractiveness through means such as changes in perceived age and sexual dimorphism [2, 4, 8, 17, 33]. Overall, the evidence suggests that facial attractiveness serves as a composite signal sensitive to diet quality and carbohydrate-related metabolic pathways.

3.1 Diet-Derived Skin Coloration as a Cue of Attractiveness

Lefevre and Perrett conducted three studies, each involving 60 participants (predominantly Caucasian), with facial images systematically varied along empirically derived carotenoid and melanin color axes. Preferences emerged for both increased carotenoid ($p < 0.001$, Cohen's $d = 4.00$) and melanin pigmentation ($p < 0.001$, $d = 2.93$) relative to low-pigment baselines. However, direct comparison revealed a strong preference for carotenoid-enhanced coloration, with carotenoid faces selected in 75.9% of trials ($p < 0.001$, $d = 2.79$). This preference appeared marginally more pronounced for female faces. One possible explanation is that melanin darkening visually overlaps with masculine facial characteristics, which enhances attractiveness for male faces but may diminish the attractiveness benefit of tanning for female faces, as it deviates from female sex-typical skin coloration [30].

Building on this evidence, Whitehead et al. used a psychophysical manipulation paradigm and reported convergent results that support a causal relationship between carotenoid intake and perceived health. Sixteen Caucasian participants were asked to adjust the skin color of 30 facial identities, using a two-dimensional color matrix derived from spectrophotometric measurements of carotenoid and melanin effects. To optimize healthy appearance, participants consistently added more carotenoid-associated coloration than melanin-associated coloration ($p < 0.001$). Notably, this preferred color shift equated to an estimated increase of 7.75 daily portions of fruits and vegetables, indicating how dietary carotenoids can directly influence perceived health through visible changes in skin coloration [33].

Preferences for carotenoid-enhanced skin coloration show both cross-cultural commonalities and important cultural variation. In Ip et al., participants from both Caucasian (Study 1, N = 131) and Hong Kong Chinese groups (Studies 2 and 3, N = 69 and N = 141) evaluated images varying in carotenoid coloration. Notably, high-carotenoid versions were significantly preferred in both facial and body images by all participant groups (all $p < 0.001$) [34]. These data demonstrate carotenoid-associated coloration as a widespread, cross-cultural cue concerning attractiveness, though important cultural nuances remain. Han et al. found that Chinese and Caucasian UK observers showed opposite preferences along the yellowness axis: Chinese participants preferred faces with decreased yellowness, whereas Caucasian UK participants preferred faces with increased yellowness [35]. This contrast suggests that the specific perceptual weighting of carotenoid-related color dimensions may vary by cultural context, and that appearance-based dietary interventions should be culturally validated before broad deployment.

It bears noting that the relationship between carotenoid coloration and actual physiological health is not straightforward. Experimental work by Foo et al. demonstrated that beta-carotene supplementation increased skin yellowness and enhanced perceived health and attractiveness in men, yet produced no measurable improvements in oxidative stress, innate immune function, or semen quality [4]. Similarly, carotenoid supplementation in healthy adults does not consistently improve antioxidant defenses or biomarkers of oxidative stress under low-stress, apparently healthy conditions [36]. These findings indicate that carotenoid coloration functions primarily as a perceptual cue to health status rather than a direct index of verified physiological health. The language throughout this review reflects this distinction: dietary carotenoids influence the perception and signal of health, and their relationship to underlying immune competence or metabolic fitness, while theoretically plausible, should not be overstated in the absence of direct biomarker evidence. Importantly, this limitation does not diminish the translational value of appearance-based feedback, since the behavioral motivation it provides operates through perceived rather than objectively measured changes.

3.2 Diet-Induced Skin Color Change from Whole-Food Intake

Observational and experimental evidence confirms that carotenoid-associated skin coloration reflects habitual dietary intake and changes measurably over short timeframes. Crucially, the carotenoid-rich foods responsible for these effects, principally fruits and vegetables, are the defining components of plant-forward dietary patterns. Studies comparing dietary groups demonstrate this link directly. In the Adventist Health Study-2, vegans had 56% higher total plasma carotenoid concentrations than omnivores, with two-fold higher α-carotene and 91% higher β-

carotene [37]. Vegetarians show approximately 15% higher total plasma carotenoids than omnivores [38], and controlled feeding trials confirm that increasing carotenoid-rich fruit and vegetable intake raises both plasma carotenoids and skin yellowness within weeks [39, 40]. These findings directly support the inference from carotenoid-level effects to plant-forward dietary patterns: while much of the experimental evidence involves specific carotenoid-rich foods rather than dietary patterns assessed holistically, plant-forward diets are, by definition, the dietary context in which carotenoid intake is highest and most sustained [1, 8, 29, 31]. In a dietary survey of 82 Caucasian adults, Stephen et al. found that higher fruit and vegetable intake was significantly associated with increased skin yellowness ($p < 0.05$); spectral analyses verified carotenoid absorption as the underlying mechanism, with correlations reaching statistical significance across multiple skin regions ($p < 0.013$). Furthermore, in a companion psychophysical study, 70 participants preferentially increased carotenoid coloration over melanin to maximize perceived health ($p < 0.001$) [8].

In support of these observations, Whitehead et al. extended this evidence longitudinally by tracking 35 participants over six weeks. Changes in fruit and vegetable intake were significantly correlated with changes in skin yellowness ($p = 0.038$) and redness ($p = 0.045$). Psychophysical threshold testing demonstrated that increases of approximately 2.9 portions/day were sufficient to increase perceived health, whereas approximately 3.3 portions/day were required to improve perceived attractiveness [1].

Tan et al. conducted a randomized controlled trial (RCT) in 81 Malaysian Chinese university students, assigning participants to consume either a carotenoid-rich fruit and vegetable smoothie (~25.4 mg carotenoids/day) or mineral water for six weeks. Spectrophotometric measurements detected significant increases in skin yellowness and redness in the intervention group after four weeks (both $p < 0.001$), with effects persisting through follow-up. Spectral analyses verified that these changes were attributable to carotenoid deposition rather than shifts in melanin or hemoglobin [31].

Adding to this body of evidence, Appleton et al. explored the effects of short-term, real-world dietary change by testing whether brief increases in fruit and vegetable intake could produce detectable changes in appearance and attractiveness. In their this-week RCT, 30 habitual low-fruit and vegetable consumers in Belfast were randomized to consume 2, 5, or 8 portions of fruits and vegetables per day. To assess outcomes, seventy-three independent observers rated facial images using 100 mm visual analog scales. Direct effects on attractiveness ratings were absent. However, elevated fruit and vegetable intake correlated with increased skin yellowness, which then indirectly predicted higher attractiveness ratings in female faces ($p < 0.05$) [29]. These findings suggest that biologically detectable changes in appearance may precede conscious judgments of attractiveness, particularly over short intervention periods.

3.3 Glycemic Load and Refined Carbohydrates as Non-Coloration Pathways

In contrast to carotenoid-rich diets, dietary patterns characterized by high glycemic load and refined carbohydrate intake affect facial attractiveness through mechanisms distinct from those underlying skin pigmentation. Berticat et al. examined 99 healthy young adults and estimated refined carbohydrate intake using meal-specific glycemic load calculations based on food composition tables and reported serving sizes. Attractiveness was assessed by 150 opposite-sex

raters viewing paired facial photographs. Higher between-meal glycemic load was associated with increased attractiveness ratings ($p = 0.001$ for men; $p = 0.007$ for women), with effects mediated by increased apparent age in men and increased perceived femininity in women [2].

Visine et al. extended the experimental evidence base for acute and chronic glycemic effects on attractiveness using a controlled mixed-design study in 104 French adults. Researchers randomly assigned participants to consume either a high- or low-glycemic isocaloric breakfast. Participants were photographed two hours later. Attractiveness ratings from 252 independent raters revealed that acute high-glycemic intake significantly reduced attractiveness in both men ($p < 10^{-6}$) and women ($p < 10^{-10}$). For chronic glycemic load, calculated by summing the glycemic index-weighted carbohydrate content independent of energy intake across three daily meals, researchers found that higher loads generally reduced attractiveness. However, the effect was reversed for the afternoon snack in men. This effect was mediated by increased age appearance in women ($p = 0.013$) and reduced perceived masculinity in men ($p = 0.015$). Because these effects occurred rapidly and independently of changes in pigmentation, the results show that carbohydrate quality modulates attractiveness through perceptual pathways distinct from those associated with carotenoid-associated skin coloration [17].

The divergent directions of these results likely reflect differences in study design, temporal scale, and the ecological meaning of glycemic exposure. For example, Berticat et al. assessed habitual, meal-specific glycemic load under naturalistic conditions. In such settings, refined carbohydrate consumption, especially between meals, may signal an evolutionary ability to secure rare, energy-dense resources or affect hormonally mediated sexual dimorphism in young adults. In contrast, Visine et al. experimentally isolated both acute and cumulative glycemic effects. Their outcomes confirmed immediate and robust reductions in attractiveness following a high-glycemic breakfast. Taken together, these results indicate that, although refined carbohydrate intake may convey context-dependent or evolutionarily mismatched signals in observational studies, diets that limit refined carbohydrates at meals, resulting in a lower glycemic impact, may align more closely with appearance indicators of health and attractiveness. A plausible biological mechanism connecting chronic high glycemic load to changes in facial characteristics involves hyperinsulinemia: chronically elevated insulin stimulates androgen synthesis and increases the quantity of free, active androgens in the blood, potentially altering the environment that shapes secondary sexual traits such as facial masculinity and femininity [2, 17]. This hormonal pathway may explain why the effects of refined carbohydrate intake on attractiveness are mediated through perceived masculinity in men, whereas for women, the effects appear mediated through perceived age, likely resulting from glycation processes caused by chronic hyperglycemia [17]. These chronic physiological pathways help explain why observational patterns of chronic dietary intake diverge from acute experimental findings regarding immediate carbohydrate consumption [17].

4. Olfactory Pathways: The Influence of Diet, Sweat Chemistry, and Microbial Metabolism

Body odor results from the interaction between apocrine gland secretions and skin-resident microbiota [12, 13]. Although apocrine sweat is initially odorless, it contains lipids and amino acids that axillary bacteria, particularly corynebacteria, metabolize into aromatic chemicals that produce body odor [12, 13]. Diet is a primary non-genetic factor that affects both sweat composition and its microbial transformation. Zuniga et al. investigated these associations through an observational

study involving 43 male odor donors and nine female judges. The study used objective skin spectrophotometry as a proxy for carotenoid-rich fruit and vegetable intake, alongside a food frequency questionnaire assessing habitual diet over the previous year. Increased skin yellowness was significantly correlated with more pleasant-smelling sweat ($r = 0.31$), independent of odor intensity, and was qualitatively described as more floral, fruity, sweet, and medicinal. In contrast, lower fruit and vegetable intake was associated with animal-like, meaty, and oily odor descriptors [13]. This evidence supports the role of carotenoids as plausible contributors to olfactory attractiveness.

Experimental studies provide additional support for these observational findings. Havlicek and Lenochova utilized a controlled, within-subject design to assess the effects of red meat consumption on male axillary odor. Seventeen men adhered to either a two-week meat-rich or non-meat diet, after which sweat samples collected during the final 24 hours were evaluated by thirty female raters. Sweat from non-meat diets was rated as significantly more attractive, more pleasant, and less intense ($p = 0.01$), while masculinity ratings remained unchanged [12]. This trial demonstrates the causal impact of diet on hedonic odor quality, indicating that even short-term dietary changes can alter scent signals relevant to social and sexual signaling. Collectively, these results indicate that diet composition, encompassing a range of proteins and fats beyond fruit and vegetable intake alone, can dynamically influence the human odor signature.

Despite these convergences, significant differences exist among studies, particularly regarding protein intake. Zuniga et al. found that self-reported consumption of meat, eggs, and tofu correlated with more pleasant sweat, whereas Havlicek and Lenochova observed that red meat consumption reduced odor attractiveness. This disparity highlights a potential conflict between long-term, self-reported data and short-term, controlled experimental findings. Variations in measurement methods also contribute to these differences; for example, the food frequency questionnaire used by Zuniga et al. assessed average intake over one year, which may have obscured acute dietary effects. The researchers also included a broad “meat” category, rather than red meat specifically. By including qualitative odor descriptors and objective carotenoid proxies, these studies provide a more nuanced insight into how specific nutrients influence body odor beyond general protein intake.

Contrary to common assumptions, garlic consumption may increase the attractiveness of body odor, despite its distinctive effect on breath odor. Fialová et al. conducted three within-subject experiments ($N = 10$, 16, and 16 donors; 82 female raters) testing 6 g and 12 g raw garlic and 12 g garlic extract versus no-garlic controls. No significant effect emerged at the lowest dose. Still, at 12 g (both raw and extract), garlic consumers’ odor was rated as significantly more attractive, more pleasant, and less intense, suggesting a dose-response relationship. Proposed mechanisms include enhanced antioxidant capacity, which may reduce peroxide-related odor compounds, and the antibacterial properties of garlic, which may lower concentrations of odor-producing axillary microbes [41]. Notably, several commonly consumed fruits and vegetables, including apple, lettuce, and spinach, have been reported to attenuate garlic-associated breath odor via enzymatic deodorization, suggesting that when garlic is consumed within a plant-rich dietary pattern, its axillary benefits may occur without a corresponding effect on breath odor [42, 43].

Overall, the evidence indicates that diet is a modifiable determinant of male body odor, with carotenoid-rich fruit and vegetable intake emerging as the most consistently beneficial factor for olfactory attractiveness. The garlic findings, while intriguing, should be interpreted with caution: a dose-dependent positive effect on axillary odor attractiveness was observed in one publication

comprising three experimental studies [41], but the authors note that analogous research is currently missing from the literature, limiting the strength of conclusions that can be drawn about garlic as a generalizable dietary recommendation for odor improvement.

5. Physical Attractiveness, Adiposity, and Dietary Patterns

Physical attractiveness is a complex, multi-dimensional construct influenced by facial and aromatic cues, as well as by adiposity [18]. Using evolutionary fitness modeling, Xia et al. predicted that male physical attractiveness peaks at a body mass index (BMI) between 23.2 and 24.8 kg/m^2. This hypothesis was evaluated using dual-energy x-ray absorptiometry (DEXA)-derived images of 15 male bodies, which were rated by male and female observers in China, Lithuania, and the United Kingdom. The outcomes indicated a peaked relationship between both body fat percentage and BMI with attractiveness, with optimal BMI values observed within a wider range of approximately 23-27 kg/m^2. When both adiposity and shoulder-to-waist ratio were modeled together, adiposity accounted for a greater proportion of variance in attractiveness ratings across all populations. These results indicate that observers are particularly sensitive to adiposity as a cue of male attractiveness, consistent with evolutionary expectations [18]. Several methodological caveats bear emphasis: the study used a small sample of 15 male bodies, did not directly test dietary interventions, and the specific attractiveness peak identified does not guarantee that plant-forward dietary patterns would facilitate attainment of exactly that body composition range. The association between plant-forward diets and male attractiveness via adiposity is therefore indirect and inferential rather than directly empirically tested. For female bodies, the broader attractiveness literature shows that lower adiposity is generally preferred by observers, with no clear peak in attractiveness detected down to at least BMI = 19 across 10 diverse populations [44]. Research using body composition manipulation has found that the most attractive apparent fat mass for women (approximately 16%) falls below the physiologically healthy range of 21-33% [45], a finding with ethical implications discussed in Section 7.1 below.

The adiposity ranges associated with attractiveness are particularly relevant when considered alongside current dietary patterns and population-level weight status in the United States. National survey data indicate that fewer than 10% of Americans report following vegetarian or vegan diets [46, 47], and analysis of National Health and Nutrition Examination Survey (NHANES) data shows that fewer than 2% of U.S. adults are non-meat-eaters [48]. Concurrently, over 42% of U.S. adults meet criteria for obesity [49]. A recent systematic review and meta-analysis found that plant-based diets are associated with greater reductions in BMI and body fat compared to omnivorous diets [50]. Although these studies do not directly assess attractiveness, the findings indicate that plant-forward dietary patterns may facilitate the attainment of adiposity levels linked to higher male attractiveness [18]. Across both sexes, the direction of the adiposity-attractiveness association, with lower body fat being associated with higher attractiveness ratings [44, 45], is broadly consistent with the observation that plant-forward dietary patterns are associated with lower BMI and greater body fat reduction relative to animal-based diets [50]. Plant-forward diets may therefore represent a modifiable factor relevant to both obesity reduction and attractiveness-related body composition, while acknowledging that this connection is inferential and has not been tested in studies measuring both dietary patterns and attractiveness outcomes simultaneously. Key studies supporting these three pathways and their links to plant-forward dietary patterns are summarized in Table 1.

Table 1 Summary of Key Evidence Linking Plant-Forward Dietary Patterns to Attractiveness Outcomes.

Study	Design	N/Population	Dietary Exposure	Outcome Measure	Main Finding	Limitations
***Pathway 1: Facial Appearance — Carotenoid Skin* Coloration**						
Lefevre & Perrett 2015 [30]	3 perceptual studies	N = 60/study; predominantly Caucasian UK adults	Carotenoid vs. melanin coloration (image manipulation)	Rated attractiveness preference	Strong preference for carotenoid over melanin coloration; carotenoid faces selected in 75.9% of trials; d = 2.79 (carotenoid vs. melanin)	Image-manipulation paradigm; UK adults only; no dietary assessment
Stephen et al. 2011 [8]	3 studies (cross-sectional, experimental, and psychophysical)	N = 225; Caucasian and Black South African adults	Dietary intake and beta-carotene supplementation; spectrophotometry	Skin yellowness (b*); rated health appearance	Higher fruit/vegetable intake associated with increased skin yellowness ($p < 0.05$); spectral analysis and supplementation confirmed carotenoids as the mechanism; participants across cultures preferred increased yellowness, and carotenoid over melanin coloration to optimize health appearance ($p < 0.001$)	Cross-sectional component limits causal inference; supplement dose may exceed habitual dietary range

Han et al. 2018 [35]	Experimental; two-alternative forced choice	N = 196; Caucasian UK (n = 101) and Chinese (n = 95) adults; 20 face stimuli	Global facial color manipulation along CIELab axes (yellowness, lightness, redness); ±3 units per axis	Rated facial attractiveness and perceived health	Significant cultural divergence in yellowness preferences: Caucasian UK preferred increased yellowness (beta = 0.45, p = 0.007); Chinese preferred decreased yellowness (beta = -1.01, p < 0.001); main effect of participant ethnicity (beta = -1.48, p < 0.001); preferences consistent across own-race and other-race faces	Chinese participants were UK residents (~1 year); stimuli limited to 20 identities
Whitehead et al. 2012 [1]	Longitudinal observational; psychophysical	N = 35; Caucasian adults, 6 weeks	Change in fruit and vegetable intake	Skin yellowness (b*); rated health and attractiveness	Increased intake correlated with increased skin yellowness (p = 0.038) and redness (p = 0.045); ~2.9 portions/day needed to improve perceived health, ~3.3 portions/day for attractiveness	Small sample size; self-reported intake; no rater-blinding

Tan et al. 2015 [31]	RCT	N = 81; Malaysian Chinese university students, 6 weeks	Carotenoid-rich fruit/vegetable smoothie (~25.4 mg carotenoids/day) vs. mineral water	Skin yellowness (b*) redness (a*), and luminance (L*); spectrophotometry	Significant increases in skin yellowness and redness at 4 weeks (both $p < 0.001$); effects confirmed as carotenoid-driven	Single ethnic group; smoothie not representative of habitual diet
Appleton et al. 2018 [29]	RCT	N = 30 donors; 73 raters; low-intake Belfast adults	2, 5, or 8 portions/day of fruit and vegetables	Skin yellowness; rated attractiveness (100 mm VAS)	No direct effect on attractiveness; skin yellowness indirectly predicted attractiveness in female faces ($p < 0.05$); suggests appearance changes precede conscious attractiveness judgments	Short follow-up (4 weeks); small donor sample
Pathway 1: Facial Appearance — Glycemic Load						
Berticat et al. 2020 [2]	Cross-sectional observational	N = 99; French young adults; 150 raters	Habitual meal-specific glycemic load (food composition tables)	Opposite-sex rated facial attractiveness; apparent age; perceived femininity/masculinity	Higher between-meal GL associated with greater attractiveness (men $p = 0.001$; women $p = 0.007$); mediated by apparent age (men) and perceived femininity (women)	Cross-sectional; self-reported diet; GL derived from food tables, not biomarkers

Visine et al. 2024 [17]	Controlled mixed design	N = 104; French adults; 252 raters	Acute: high- vs. low-GL isocaloric breakfast. Chronic: habitual GL across 3 meals	Opposite-sex rated attractiveness; apparent age; perceived masculinity/femininity	Acute high-GL breakfast reduced attractiveness in men ($p < 10^{-6}$) and women ($p < 10^{-10}$); chronic GL generally reduced attractiveness (except for men's afternoon snack); mediated by apparent age (women) and masculinity (men)	French adults only; photographs at fixed 2 h post-meal; chronic GL self-reported
Pathway 2: Olfactory Signals — Diet and Body Odor						
Havlicek & Lenochova 2006 [12]	Within-subject crossover	N = 17 donors; 30 female raters; 2 weeks/condition	Meat-rich vs. non-meat diet; axillary sweat collected last 24 h	Hedonic ratings: attractiveness, pleasantness, intensity, masculinity	Non-meat diet produced more attractive, more pleasant, less intense odor ($p = 0.01$); masculinity ratings unchanged; limitation: all male donors	All-male donors; small N; 2-week conditions may be insufficient for full dietary adaptation
Zuniga et al. 2017 [13]	Observational	N = 43 male donors; 9 female raters; Australian adults	Skin spectrophotometry (carotenoid proxy) + food frequency questionnaire	Hedonic ratings (liking, attractiveness, health) of axillary sweat; odor descriptors	Higher skin yellowness (carotenoid proxy) correlated with more pleasant, floral/fruity sweat ($r = 0.31$) and floral/fruity qualities; less yellow skin was associated with animal,	Observational design; carotenoid proxy indirect

					meaty, and oily descriptors; lower intake associated with meaty/oily descriptors	
Fialova et al. 2016 [41]	3 within-subject experiments	N = 10/16/16 donors; 82 female raters	Raw garlic (6 g vs. 12 g) or garlic capsules (12 g extract) vs. no-garlic control	Hedonic ratings of axillary odor: attractiveness, pleasantness, intensity, masculinity	Study 2 (12 g raw garlic): significantly more attractive, pleasant, and less intense; Study 3 (12 g extract): significantly more attractive and less intense; Study 1 (6 g raw garlic): no significant effect; dose-response pattern	Not independently replicated; small N per study; short exposure window (12 h pad collection)
Pathway 3: Adiposity, Body Composition, and Dietary Patterns						
Xia et al. 2025 [18]	Cross-cultural perceptual rating	15 DEXA male bodies; 283 raters from China, Lithuania, UK	DEXA-derived body fat % and BMI; shoulder-to-waist ratio	Rated attractiveness	Peaked attractiveness at BF% ~13-14% and BMI ~23-27 (males); adiposity explained more variance than shoulder-to-waist ratio	Only 15 male stimulus bodies; no dietary assessment; inferential link to dietary patterns
Wang et al. 2015 [44]	Cross-cultural perceptual rating	N = 1,327 (817 female/509 male) across 10 populations (Caucasian, Asian,	BMI and body fat % images	Rated female attractiveness	Inverse linear relationship between body fatness and attractiveness in all 10 populations; lower fat	Body images only; no dietary assessment of stimulus subjects; did not

		African); female stimuli; BMI 19-40			more attractive down to BMI = 19; no attractiveness peak found in range studied	examine BMI < 19
Brierley et al. 2016 [45]	Experimental; computer-applet body manipulation	N = 63 observers (30 female, 33 male); Australian undergraduates; 30 Caucasian stimulus identities	Apparent fat mass and muscle mass (kg); manipulated via image morphing along empirically derived dimensions	Optimized body attractiveness and apparent health via applet	Most attractive fat mass in women (M = 9.48 kg, ~16.3% BF) significantly lower than healthiest-appearing fat mass (M = 11.14 kg, ~19.2% BF); both fell below physiologically healthy range (21-33% BF); $t(62) = 4.80$, $p < 0.001$; $\eta p^2 = 0.18$	Caucasian stimulus bodies only; undergraduate sample
Mambrini et al. 2025 [50]	Systematic review	Multiple RCTs and cohort studies including 2 RCTs and 4 cohort studies	Sustainable plant-based diets (EAT-Lancet model)	BMI; body fat; obesity risk	Plant-based diets associated with greater reductions in BMI and body fat vs. normal or animal-based diets; does not assess attractiveness directly	Does not assess attractiveness outcomes; heterogeneous dietary definitions across included studies
Behavioral Interventions						
Whitehead et al. 2013 [16]	RCT	46 completers (randomized to 3 groups)	Personalized (own-face) vs. generic skin color visualization vs.	Fruit and vegetable intake (portions/day)	Personalized skin color visualization produced significant, sustained increases in intake (p <	Single-center UK RCT; short follow-up (10 weeks); no long-

	information-only control	0.05); generic and information-only controls did not	term maintenance data

Abbreviations: BF = body fat; BF% = body fat percentage; BMI = body mass index; CIELab = Commission Internationale de l'Éclairage L*a*b* color space; DEXA = dual-energy X-ray absorptiometry; GL = glycemic load; RCT = randomized controlled trial; VAS = visual analog scale; ηp^2 = partial eta squared.

6. Patterns Multimodal Synthesis: Integrating Facial Coloration, Body Odor, and Adiposity

Judgments of human attractiveness are inherently multimodal, merging visual, olfactory, and morphological cues into a unified assessment of health and mate value [5, 28]. Emerging evidence indicates that these modalities are partially independent but weakly correlated, revealing discrete biological processes rather than redundant signaling [5, 28, 51]. Facial skin coloration serves as a prominent visual anchor within this system, while body odor and body composition provide complementary information regarding metabolic and immunological status [8, 13, 15].

Carrito et al. present empirical support for cross-modal associations between visual and odor cues. In their study, axillary odor samples were collected from 18 healthy male donors under standardized conditions and rated for attractiveness and health by 42 female raters using a multilevel modeling framework. Facial photographs of the same donors were analyzed with spectrophotometric measures to quantify skin color along masculinity-related dimensions, specifically darker, yellower, and redder coloration. The findings showed that men with more masculine facial skin coloration were judged to have significantly more attractive-smelling body odor ($p = 0.022$) and healthier-smelling odor ($p = 0.005$) [14]. These data suggest that diet- and health-sensitive skin pigmentation may predict olfactory attractiveness, offering empirical evidence for partial coherence between visual and chemosensory cues.

The more extensive literature indicates that such coherence is modest rather than strong. Třebický et al. conducted a systematic review and meta-analysis to examine the congruence between attractiveness assessments across sensory modalities, specifically facial appearance, body odor, and vocal attractiveness. By synthesizing data from 25 studies on facial-odor associations and 9 studies on odor-voice associations, the researchers observed small but significant positive correlations ($r \approx 0.10$) between modalities, with no consistent sex differences. These effect sizes offer limited support for the backup signals hypothesis, which predicts strong redundancy across cues, and instead correspond more closely with the multiple messages hypothesis, in which different modalities convey partially independent information about mating-related quality [28]. In this context, facial coloration, body odor pleasantness, and adiposity may each reflect distinct aspects of nutritional status, immune function, and metabolic health.

Collectively, this evidence supports a model in which whole-food, plant-forward diets influence attractiveness through coordinated yet non-redundant pathways. Carotenoid-rich fruits and vegetables contribute to facial skin coloration [8, 29, 31, 52-54], carbohydrate quality affects perceptual cues such as apparent age and sexual dimorphism [2, 7, 17, 55-57], dietary composition shapes sweat chemistry and microbial metabolism [12-15, 27], and long-term dietary patterns impact adiposity [13, 18, 27, 56, 58, 59]. The convergence of these effects across modalities improves the biological plausibility of diet as a modifiable determinant of attractiveness. It is consistent with conceptual models that emphasize multiple, partially independent signals. Figure 1 provides a schematic overview of these three pathways and their convergence on perceived attractiveness and potential motivation for dietary behavior change.

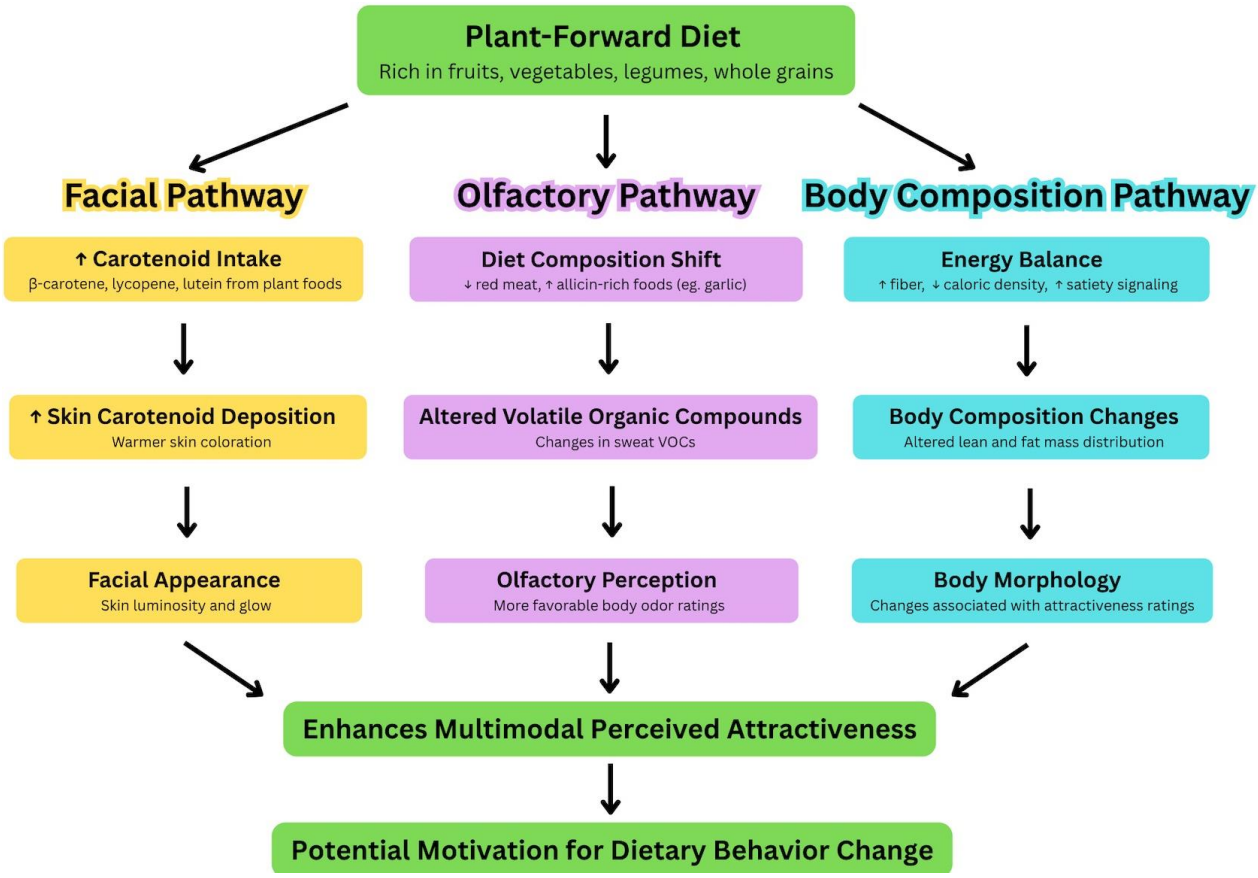

Figure 1 Conceptual model illustrating how plant-forward dietary patterns may influence physical attractiveness through three partially independent biological pathways. Carotenoid-rich fruits and vegetables act most rapidly, producing measurable changes in skin coloration within weeks; dietary composition effects on sweat volatile organic compounds operate on a similarly short timescale; and adiposity-related changes emerge over longer periods of sustained dietary adherence. The convergence of these pathways toward multimodal perceived attractiveness suggests that diet-induced appearance changes may provide proximal, personally relevant reinforcement for continued dietary behavior change.

7. Implications for Health and Behavioral Interventions

The relationship between diet and socially salient appearance cues has considerable ramifications for public health, nutrition promotion, and behavioral interventions. As facial skin coloration and body odor can change within weeks of dietary modification, diet offers a concrete and rapidly reinforcing means to improve perceived health and attractiveness [1, 12]. Perceptual feedback of this nature may be especially effective among individuals motivated by appearance-related outcomes, because it capitalizes on immediate social rewards rather than the prospect of avoiding disease in the distant future [4]. In the context of plant-forward dietary promotion, highlighting the visible and olfactory benefits of increased fruit and vegetable consumption may function as a useful complement to established messages centered on chronic disease prevention.

Empirical research demonstrates the translational potential of appearance-based interventions. In an RCT, Whitehead et al. found that participants who viewed personalized visualizations of diet-

induced changes in skin color showed substantial and sustained increases in fruit and vegetable intake over 10 weeks ($p < 0.05$). In contrast, interventions providing only information or generic appearance cues did not result in behavioral change [16]. Supporting evidence from a large online survey (N = 802) by Cairns et al. indicated that 57% of participants were motivated by a simple demonstration of diet-related skin color change, with motivation consistent across socioeconomic and ethnic groups [3]. Similarly, Perrett et al. reported that exposure to altered self-appearance at the start of a study prompted dietary changes sustained for 10 weeks, whereas standard health information was ineffective [6]. This evidence collectively shows that personalized, visual feedback is a more effective mechanism for dietary behavior change than generic health messaging.

Despite encouraging findings, several methodological and translational limitations need to be addressed. Changes in appearance do not always correspond directly to physiological health outcomes; for instance, increasing skin carotenoid levels through dietary supplementation may improve perceived health without affecting oxidative stress or immune function [4]. Additionally, Appleton et al. observed that short-term increases in fruit and vegetable intake resulted in only modest improvements in perceived attractiveness, casting uncertainty on the sufficiency of appearance-based motivation to sustain extended dietary adherence. Furthermore, odor cues are influenced by recent dietary intake and personal hygiene routines, introducing variability that should be accounted for in intervention design [12, 13].

Integrating appearance-based feedback with comprehensive nutritional education and structural support for plant-forward eating may improve the efficacy of future trials. Employing multimodal strategies that combine facial imaging, odor assessment, and body composition measurements could reveal the relative and interactive effects of various signals over time. Conceptually, framing attractiveness as a health incentive shifts the focus from distant, abstract disease risk to immediate, tangible indicators of vitality. When executed with care, these approaches may increase engagement with whole-food, plant-rich dietary patterns while supporting long-term public health objectives.

7.1 Ethical Considerations, Cultural Variability, and Safeguards

Framing dietary behavior change around attractiveness raises ethical considerations that warrant explicit attention. Appearance-based health messaging has been found to carry risks of reinforcing harmful body image norms, increasing self-objectification, and exacerbating thin-ideal internalization [60, 61]. Weight-centric messaging may increase body shame, particularly in individuals at elevated risk for eating disorders, and stigmatizing campaigns neither motivate behavior change nor avoid negative psychological outcomes [61]. These considerations necessitate careful design of any appearance-based dietary interventions.

Importantly, the approach examined in this review differs from potentially problematic appearance-framed campaigns in a key respect. Rather than solely focusing on body composition, it centers on the biologically grounded and visually detectable effects of increasing fruit and vegetable intake on skin coloration, a change that occurs within the existing body without requiring weight loss or body reshaping. Research specifically examining weight-based messaging for fruit and vegetable promotion found that adverse effects were low and comparable to health-based messaging, with the approach being particularly effective among younger women [62].

Nevertheless, practitioners should screen for vulnerabilities to disordered eating, avoid language equating attractiveness with worth, and frame outcomes in terms of health and vitality.

Cultural variability in attractiveness norms also limits the universality of appearance-based messaging. Body size ideals vary substantially by socioeconomic status and geography: larger bodies have traditionally been idealized in parts of Africa and the South Pacific, though Westernization and rising socioeconomic status have narrowed these differences [63]. For skin coloration, Chinese and Caucasian UK observers show opposite preferences along the yellowness axis, with Chinese observers preferring decreased yellowness. In contrast, Caucasian UK observers prefer increased yellowness [35], a finding directly relevant to carotenoid-based messaging. Appearance-based dietary interventions should therefore be culturally validated before broad deployment.

8. Conclusion

Converging evidence from experimental, observational, and cross-cultural research demonstrates that human attractiveness serves as a diet-sensitive, multimodal signal that integrates facial appearance, body odor, and body composition. Diet quality shapes these indicators through multiple biological pathways, such as carotenoid-derived skin coloration from fruit and vegetable intake, glycemic load-dependent effects on perceived age and sexual dimorphism, diet-driven modulation of sweat chemistry and microbial metabolism, and longer-term impacts on adiposity. These pathways operate on unique temporal scales and convey partially independent information, consistent with multiple-message models of sexual signaling rather than redundant backup signals. Facial skin coloration is a particularly salient visual cue, reflecting habitual intake of carotenoid-rich foods and serving as an integrative marker of nutritional status that modestly covaries with olfactory attractiveness and metabolic health. Refined carbohydrate intake can also promptly alter attractiveness through non-pigmentary mechanisms, highlighting the role of carbohydrate quality alongside overall dietary patterns. Collectively, the data support the biological plausibility of diet as a modifiable determinant of socially relevant appearance cues.

From a translational perspective, the rapid perceptibility of diet-induced changes in appearance delivers an innovative complement to traditional health promotion initiatives that concentrate on long-term disease outcomes. Appearance-based feedback may enhance motivation for dietary change by presenting immediate, personally relevant reinforcement, especially when incorporated into larger measures that promote the consumption of whole or minimally processed plant foods. However, caution is necessary when extrapolating short-term perceptual effects to long-term health outcomes. Further investigations should integrate longitudinal dietary interventions with objective physiological and multimodal perceptual assessments. By placing diet-appearance relationships at the intersection of evolutionary biology, sensory perception, and public health nutrition, this work offers a promising yet underexplored paradigm for assessing how everyday food choices influence visible and socially meaningful signals of human health.

Abbreviations

BF	Body Fat
BF%	Body Fat Percentage
BMI	Body Mass Index
CIELab	Commission Internationale de l'Éclairage L*a*b* color space
COPE	Committee on Publication Ethics
DEXA	Dual-Energy X-ray Absorptiometry
GL	Glycemic Load
NHANES	National Health and Nutrition Examination Survey
RCT	Randomized Controlled Trial
VAS	Visual Analogue Scale
ηp^2	Partial Eta Squared

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Conceptualization, D.G.; methodology, D.G.; investigation, D.G. and M.N.; writing—original draft preparation, D.G. and M.N.; writing—review and editing, D.G. and M.N. All authors have read and agreed to the published version of the manuscript.

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Competing Interests

David Goldman consults for Metabite, Inc. and has consulted with Soy Nutrition Institute Global. Matthew Nagra previously had partnerships via affiliate links with FYTA™ and Complement® and has consulted with Soy Nutrition Institute Global.

Data Availability Statement

No new data were created or analyzed in this study. Data sharing is not applicable to this article.

AI-Assisted Technologies Statement

The authors acknowledge the use of Grammarly, version 14.1268.0, for language editing. The tool was applied to enhance clarity and scholarly tone, and all edits were carefully reviewed and validated by the authors to ensure accuracy, compliance with academic standards, and research integrity. The authors fully support adherence to COPE guidelines on AI in publication ethics and confirm that this use has been managed responsibly and ethically.

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