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Posted Date: 4 October 2023

doi: 10.20944/preprints202310.0218.v1

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The Influence of Social Norms and Environmental Regulations on Rural Households' Pesticide Packaging Waste Disposal Behavior

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Abstract: The agricultural ecological environment provides an important resource guarantee for social development. The extensive management mode of agriculture in China has not fundamentally changed; the contradiction between production and governance is still prominent, and the management of agricultural surface pollution has a long way to go. Based on the data of 547 rural households in Jiangxi province, this paper uses the Ordered Logit, 2SLS, and moderation effect model to analyze the mechanism between social norms (SNs) and rural households' (RHs) disposal of pesticide packaging waste (PPW) and to test the moderation effect of environmental regulation (ER) in the influence path of SN to RHs' disposal of PPW. The results show that (1) descriptive and directive norms can promote RHs not to litter PPW. However, the role of surrounding crowd supervision (directive norms) is more obvious than the behavior of the surrounding crowd (descriptive norms). The consistent conclusion was still obtained after the robustness test and endogeneity treatment. (2) The results of the moderation effect test showed that reputational incentives strengthened the promotional effect of directive norms on RHs' behavior of not littering PPW; punitive regulation hindered the promotional effect of descriptive norms on RHs' behavior of not littering PPW. Based on the findings of the study, the following policy recommendations are put forward: continue to strengthen the guidance and soft binding force of informal institutions such as SNs; accurately locate the target groups and formulate differentiated measures; pay attention to the complementary nature of formal and informal institutions, and reasonably formulate environmental regulations to fit in with SNs.

Keywords: pesticide packaging waste; social norms; environmental regulation; moderating effects

1. Introduction

Amidst the escalating global demand for food, pesticides are frequently acknowledged as a vital component for enhancing agricultural production. Consequently, the global annual pesticide application rates have continuously increased [1]. As pesticide usage continues to expand over time, the accumulation of pesticide packaging waste (PPW) has emerged as an additional source of agricultural ecological pollution that warrants significant attention. Haphazardly discarded PPW exerts adverse effects on both soil and water resources, thereby posing a threat to the agricultural ecological environment and restricting agricultural green development [2]. Simultaneously, PPW typically contains 2% to 5% residual pesticide liquid, which directly infiltrates aquatic systems or the soil environment upon disposal, posing additional risks to the environment and human health [3].

Efficiently mitigating pesticide packaging pollution has emerged as a shared global concern, prompting comprehensive explorations in developed and developing countries. The World Health Organization (WHO), the Food and Agriculture Organization of the United Nations (FAO), and various international organizations assert that recycling PPW is imperative for safeguarding human health and environmental quality. It belongs to the pesticide product life cycle and is an important part of the pesticide industry, pesticide production and sale of enterprises, the government, and rural households （RHs） should bear the corresponding recycling responsibility and issued guidelines

 doi:10.20944/preprints202310.0218.v1

on the recycling of pesticide packaging waste [4]. Brazil's model of 'legislation + advocacy by pesticide industry associations + implementation by government non-profit organizations' serves as a representative case in developing countries. This model has significantly contributed to the recycling and disposal of PPW [5]. The European Union government has initiated a pilot project to manage agricultural plastic packaging waste. They have employed institutional mechanisms to delineate the responsibilities of key stakeholders, coupled with mandatory legislation and a robust pesticide regulatory framework. This approach aims to prevent evasive practices in PPW management [6]. It is evident that various countries employ distinct approaches and programs for PPW recovery. However, effective collaboration among diverse stakeholders is pivotal to ensuring successful implementation. Consequently, motivating farmers, who play a crucial role in PPW recycling, and enhancing their enthusiasm for participation have become urgent solutions to address this real-world challenge.

The academic community has a rich body of research on recycling PPW. On a micro level, variations in PPW disposal practices among RHs are influenced by individual characteristics, including age [7], education [8], agricultural training [9], and economic expectations [10]. Therefore, it is crucial to tailor approaches based on the specific conditions of agricultural production and operation [11]. Endowment characteristics, such as the number of laborers, farming experience, and cultivated land area within RHs, also significantly impact PPW disposal behavior [12]. Simultaneously, the convenience and time invested in PPW disposal also influence RHs' disposal behavior [13]. From an external perspective, some scholars have highlighted the substantial quantity of current PPW, emphasizing the alarming prevalence of haphazard disposal practices, which pose significant threats to rural environmental safety. This issue is exacerbated by the lack of precise enforcement of existing regulations and insufficient attention from environmental protection authorities, contributing significantly to the pollution problem [14,15]. Because recycling PPW by RHs generates positive externalities [16], offering subsidies to RHs has emerged as a relatively effective approach to encourage responsible disposal practices [17–19]. It is important to note that sociological scholars have examined RHs' PPW disposal behavior through the lens of SNs. They assert that SNs differ from obligatory legal mandates, representing a shared code of conduct that evolves over time through social interactions and practice. These norms play a significant role in informal systems [20]. When recycling PPW becomes a widely accepted norm among RHs, other community members will naturally follow suit [21,22]. Consequently, it is evident that RHs' behavior in managing PPW is influenced by various factors, either motivating or constraining their actions. Given the existing deficiencies in PPW disposal practices and the limited engagement of RHs in such behavior, there remains a need for a comprehensive exploration of these pertinent issues.

As a major producer and consumer of pesticides, China boasts extensive rural areas and a substantial rural population. The agricultural ecological environment supports rural development and is a crucial resource foundation for society. Statistically, China's annual agricultural production generates over 10 billion units of PPW, of which approximately 3 billion units are irresponsibly disposed of, resulting in a cumulative weight exceeding 100,000 tons [23,24]. Consequently, the Chinese government has introduced various policies and regulations to tackle the problem of PPW on an unprecedented scale. In 2018, the Soil Pollution Prevention and Control Law of the People's Republic of China, adopted during the Fifth Meeting of the Standing Committee of the Thirteenth National People's Congress, mandated that PPW must be entrusted to specialized institutions or organizations for safe disposal, thereby providing legal protection for PPW management. In 2020, the Ministry of Agriculture and Rural Affairs of China introduced the "Measures for the Administration of Recycling and Disposal of Pesticide Packaging Waste," which delineates the roles and responsibilities of producers, operators, users, and government departments. These measures ensure the continuity, supervision, and effective management of recycling and treatment activities. Additionally, in 2021, the "Law of the People's Republic of China on the Promotion of Rural Revitalization" and the "14th Five-Year" Comprehensive Work Program for Energy Conservation and Emission Reduction underscore the obligation of governments at all levels and relevant departments to expedite the recycling and treatment of agricultural input packaging waste, including used

agricultural films and pesticide containers. Nonetheless, the decentralized, concealed, and delayed characteristics of agricultural pollution necessitate a recognition that the existing policy of solely employing point source control is imperfect. Effective environmental protection demands not only governmental intervention but also widespread public engagement. RHs not only serve as the primary interface with the agricultural ecological environment but also stand as the direct beneficiaries of enhancements to this environment. Consequently, the solution to agricultural surface pollution at its root and the attainment of sustainable agricultural development can be achieved only through the regulation and guidance of RHs' production practices.

China's fundamental agricultural landscape, characterized by "a large country with small-scale farmers," has resulted in a substantial volume of discarded PPW widely dispersed nationwide. This has considerably complicated the government's efforts in recycling and regulation. Furthermore, the environmental regulatory policies inadequately account for the incongruence between institutional design and RHs' rational behavioral choices, resulting in ineffective policy constraints [25]. Hence, for the government's formal system to be more effective in exerting restraint and guidance, it must align with the rural social environment and accommodate the behavioral preferences of RHs [26]. Certain studies have posited that rural China exhibits characteristics of a humane society, underscoring the significance of informal systems in shaping the beliefs and conduct of RHs, an aspect that should not be underestimated [27]. The informal system, as embodied by SNs, serves to compensate to some extent for the deficiencies in the formal regulatory framework. It not only directly encourages RHs to make rational decisions regarding the disposal of PPW but also has the potential to become internalized as personal norms, indirectly shaping the behavioral choices of RHs. Therefore, this paper studies the mechanism of SNs and environmental regulations on the disposal behavior of PPW, which has significant meaning in regulating the decision-making of production behavior of RHs, explores the long-term mechanism of PPW disposal, and realizes the high-quality development of agriculture.

2. Theoretical analysis and research hypothesis

2.1. The Influence of Social Norms on Rural Households' Disposal of Pesticide Packaging Waste

Social norms (SNs) refer to the shared behavioral guidelines within a specific social group that evolve through social interactions [28]. They establish a sense of obligation among individuals to engage in particular actions due to their directive and constraining influences [29]. These norms encapsulate the common behaviors exhibited by the majority within a social group and involve informal oversight and guidance from fellow group members, encompassing both descriptive and directive norms [25]. According to SNs theory, individuals tend to conform to the established SNs within their respective groups, and those who deviate from these norms, whether written or unwritten, may risk exclusion or even expulsion from the group [30]. The influence of SNs on RHs' disposal of PPW primarily operates through the guidance of values, the internalization of social interactions, and the imposition of behavioral constraints.

In terms of descriptive norms, in the social group in which RHs live, the behavior of those around them creates an invisible social pressure on themselves, creating an implicit constraint. RHs strive to maintain a positive reputation within their community, and, at times, individuals emulate the behaviors of others, aligning themselves with prevalent practices [31]. The disposal of PPW carries quasi-public, negative externalities. When the behaviors, perceptions, and expectations of fellow social network members in an RH's environment lean toward favoring proper disposal practices, the RH adopts these as benchmarks, reshaping their value orientation to align with this shared standard.

Directive norms, functioning as a form of soft constraint mechanism, are upheld through informal sanctions that serve to supervise and guide behavior contravening public interests and standards. In the context of PPW disposal, when a consensus emerges within a social group that disposal practices should be adhered to, RHs anticipate moral condemnation, public opinion pressure, and group sanctions for contravening this communal agreement. This expectation is a

deterrent against non-compliance with the established norms [32], encouraging RHs to engage in PPW disposal. Based on this, this paper posits the following research hypothesis:

H1: Descriptive norms positively influence RHs' PPW disposal behavior; the less littering of pesticide packaging in villages, the higher the likelihood RHs will dispose of PPW.

H2: Directive norms positively influence RHs' PPW disposal behavior; the higher the likelihood that RHs will dispose of PPW when the surrounding population blames the phenomenon of littering.

2.2. The Moderating Effect of Environmental Regulation on the Relationship Between Social Norms and RHs' PPW Disposal Behavior

The rural environment possesses the characteristics of public goods. Descriptive and directive norms serve as informal constraints, but their voluntary nature makes independent sustainability challenging, necessitating collective reinforcement through legal frameworks and regulations. In this context, environmental regulation refers to government-issued administrative directives, such as subsidies and penalties, aimed at directly intervening in environmental resources. These measures act as incentives or constraints on RHs' production behaviors to enhance environmental quality [33].

In practice, regulating and penalizing PPW disposal is challenging. Therefore, governments and village collectives often resort to incentive-based strategies to motivate RHs. This paper references the work of Fannie Li and Junbiao Zhang (2021), which categorizes incentive regulation into economic and reputational incentives, and examines their impact on PPW disposal behavior [34]. Based on the preceding analysis, it becomes evident that SNs deter the littering of PPW by altering RHs' perceptions. Economic incentives, achieved through subsidies, reduce the financial burden associated with recycling PPW. They also reshape RHs' perceptions by mitigating the belief that disposing of such waste incurs a loss of leisure time or opportunity cost, thereby enhancing the effectiveness of SNs [35]. Simultaneously, RHs entrenched in long-term agricultural practices find it challenging to alter their habits swiftly. Depending solely on informal constraints is generally anticipated to yield limited efficacy; thus, economic incentives serve to complement the absence of SNs [22]. It is essential to note that SNs and economic incentives are interlinked; RHs operate within the confines of SNs while also being influenced by subsidies and incentives. This interaction yields a moderation effect, significantly enhancing RHs' adherence to PPW disposal practices. Based on this, this paper posits the following research hypothesis:

H3: Economic incentives play a positive moderating role in descriptive norms influencing PPW disposal behavior.

H4: Economic incentives play a positive moderating role in directive norms influencing PPW disposal behavior.

Reputation encompasses the assessment of an individual by a social group, as well as the attributes and traits attributed to that individual, representing a form of ideological capital. According to the theory of reputation utility, a positive reputation can augment the level of respect an individual receives, facilitating the development of favorable interpersonal relations—a pursuit intrinsic to individuals [36]. In rural Chinese society, interpersonal dynamics heavily rely on exchanging favors, the concept of 'face,' and cultivating relational networks. As such, RHs' behavior considerations extend beyond mere economic rationality; they also encompass social rationality, driven by the pursuit of social respect and self-worth satisfaction [37]. RHs' PPW disposal behaviors are deeply embedded within intricate social networks. While RHs adhere to SNs and earn recognition from their immediate social circles, reputation incentive policies afford individuals the opportunity to garner official recognition and reputation assessment at the governmental level. This satisfies RHs' elevated aspirations for honor, influence, and prestige within their communities, and enriches their spiritual well-being. Simultaneously, a high reputation evaluation confers official acknowledgment and reputation appraisal, while deviating from socially accepted behavioral norms can result in substantial penalties and losses [38]. Consequently, individuals are more inclined to adhere to SNs and engage in PPW disposal behavior. Based on this, this paper postulates the following research hypothesis:

 doi:10.20944/preprints202310.0218.v1

H5: Reputational incentives play a positive moderating role in descriptive norms influencing pesticide packaging waste disposal behavior.

H6: Reputational incentives play a positive moderating role in the process of directive norms influencing pesticide packaging waste disposal behavior.

The regulatory impact of SNs and punitive regulations has dual aspects [26]. On the one hand, when RHs deviate from the practice of not littering PPW, directive norms gain credibility through government regulations [39]. According to rational choice theory, when the economic and social costs of littering PPW increase, the likelihood of RHs choosing proper disposal behavior rises [40]. On the other hand, when RHs have limited ecological awareness, implementing recycling practices to avoid penalties becomes labor and time-intensive, leading to resistance. Moreover, strict punishment regulations may foster a culture of evasion among RHs, undermining social reciprocity and trust within groups, thereby partially diminishing the positive impact of descriptive norms [40]. Based on these considerations, this paper proposes the following research hypothesis:

H7: Penalty regulation plays a negative moderating role in descriptive norms influencing pesticide packaging waste disposal behavior.

H8: Penalty regulation plays a positive moderating role in the process of directive norms influencing pesticide packaging waste disposal behavior.

3. Materials and Methods

3.1. Source of Data Collection

The microdata for this study is sourced from a survey conducted in July 2021 to assess the implementation of the "Twenty Character Guidelines" associated with the Rural Revitalization Strategy within Jiangxi Province, China. Jiangxi Agricultural University and the Jiangxi Institute of Rural Revitalization Strategy collaboratively conducted this survey. This study employed a combination of stratified and random sampling techniques. Initially, the Jiangxi Rural Revitalization Research Institute, considering the effectiveness of industry, ecology, rural culture, livelihood, and governance, selected 65 "Rural Revitalization Demonstration Bases" from eight counties (cities) within the research area. As shown in Figure 1, these areas included Luxi County, Yudu County, Fuliang County, Jishui County, Jinggangshan City, Gao'an City, Xiushui County, and Wanzai County, serving as potential models for achieving rural revitalization in other villages. Subsequently, in addition to surveying the fundamental characteristics of village groups, the study randomly sampled 10 RHs from each administrative village. Data collection involved the utilization of questionnaires and structured interviews to gather information about the production and living conditions of the interviewed RHs. Out of the 650 questionnaires distributed for this study, all 650 were returned. Following the exclusion of responses with inconsistencies or missing key variables, 547 valid samples remained, resulting in a questionnaire validity rate of 84.15%.

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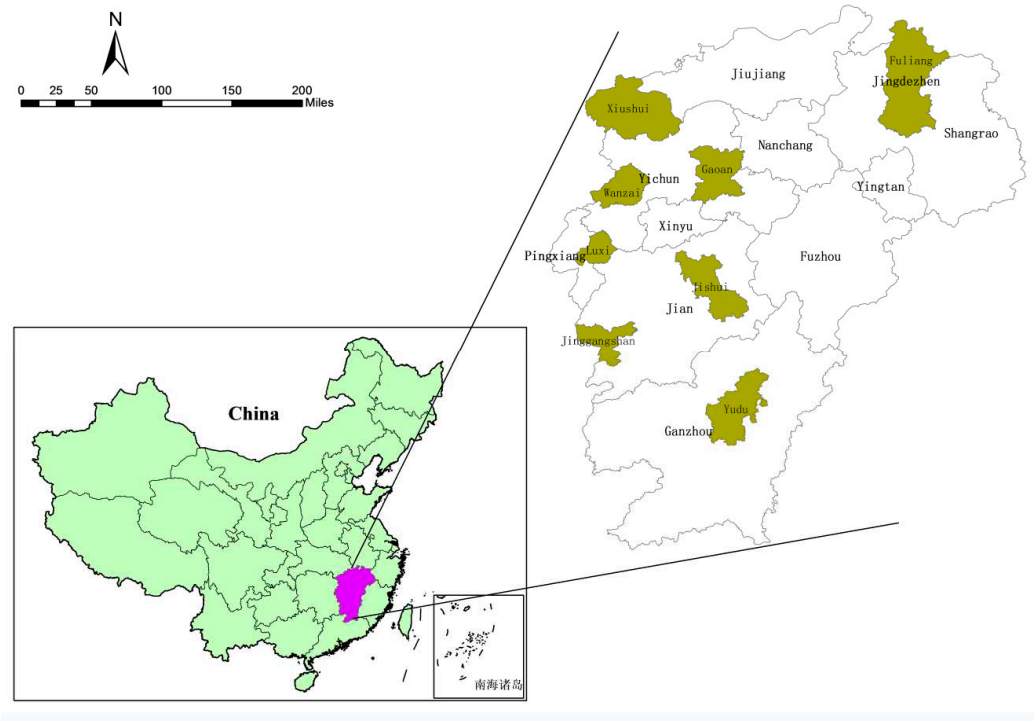

Figure 1. Map of eight pilot cities selected in this stud.

3.2. Choice Experiment Method

3.2.1. Benchmark Regression

In this section, an Ordered Logit model is employed to examine the relationship between SNs and PPW disposal behavior. It is important to highlight that the dependent variable, PPW disposal behavior, is an ordered discrete choice variable. Consequently, it is analyzed utilizing an ordered choice model, structured in the following functional form:

$$Behavior_i^*=\alpha_0+\alpha_1 norm_i+\alpha_i Control_i+\mu_i, i=1,2,3 \quad (1)$$

$$Behavior_i=\begin{cases}1, & Behavior_i\le r_1\\ 2, & r_1<Behavior_i\le r_1\\ 3, & Behavior_i>r_2\end{cases} \quad (2)$$

Within this context, $Behavior_i$ represents the latent construct associated with PPW disposal behavior. r_1, r_2 and r_3 are the intercepts, which satisfy $r_1<r_2<r_3$, norm_i encompass the descriptive and directive norms, respectively. $Control_i$ encompasses the pivotal control variables influencing PPW disposal behavior, including household head characteristics, family attributes, and village-related variables. Lastly, μ_i accounts for the random error term.

In the Ordered Logit model, the probabilities of $Behavior_i=1,2,3$ are as follows:

$$P(Behavior_i=1|norm_i)=P(\alpha_1 norm_i+\mu_i\le r_1|norm_i)=\Phi(r_1-\alpha_1 norm_i)$$

$$P(Behavior_i=2|norm_i)=P(r_1<\alpha_1 norm_i+\mu_i\le r_2|norm_i)=\Phi(r_2-\alpha_1 norm_i)-\Phi(r_1-\alpha_1 norm_i)$$

$$P(Behavior_i=3|norm_i)=P(\alpha_1 norm_i+\mu_i>r_2|norm_i)=1-\Phi(r_1-\alpha_1 norm_i) \quad (3)$$

The calculation of the marginal effect of PPW disposal behavior is as follows:

$$\frac{\partial P(Behavior_i=1)}{\partial norm_i}=-\phi(r_1-\alpha_1 norm_i)\alpha_1$$

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$$\frac{\partial P(Behavior_i=2)}{\partial norm_i}=-\phi(r_2-\alpha_1 norm_i)\alpha_1$$

$$\frac{\partial P(Behavior_i=3)}{\partial norm_i}=\phi(r_2-\alpha_1 norm_i)\alpha_1 \quad (4)$$

In equation (3), $\Phi(\bullet)$ represents the standard normal distribution function, while $\phi(\bullet)$ represents the probability density function.

3.2.2. Examining Moderation Effects

To understand how SNs influence PPW disposal behavior, we introduce an interaction term involving environmental regulation into the model. The functional form is expressed as follows:

$$Behavior_i^*=\alpha_0+\alpha_1 norm_i+\alpha_2 regulation_i+\alpha_3 norm_i\times regulation_i+\alpha_i Control_i+\mu_i, i=1,2,3 \quad (5)$$

In this context, $norm_i\times regulation_i$ represents the interaction between SNs and environmental regulation. Based on the interaction term modeling implications, the bias derivation of $norm_i$ in Eq. (5) is performed:

$$\frac{\partial Behavior_i^*}{\partial norm_i}=\alpha_1+\alpha_3 regulation_i \quad (6)$$

Analyzing the outcomes of equation (6), we observe that environmental regulation moderates the impact of SNs on farmer i's PPW disposal behavior. When α_1 and α_3 share the same sign, it signifies that environmental regulation positively moderates the influence of SNs on RHs' PPW disposal behavior. Conversely, when α_1 and α_3 have opposite signs, it indicates that environmental regulation negatively moderates the influence of SNs on RHs' PPW disposal behavior.

3.3. Variable Selection

Dependent Variable: Pesticide Packaging Waste (PPW) Disposal Behavior. PPW disposal behavior was assessed by questioning interviewed RHs. Responses were categorized as follows: "often littering" (assigned a value of 1), "occasionally littering" (assigned a value of 2), and "never littering" (assigned a value of 3). A lower numerical value indicates a more severe PPW disposal behavior.

Core Explanatory Variable: Social Norms (SNs). Descriptive norms were assessed using the following query: "To what extent is the phenomenon of pesticide packaging littering the fields in your village?" Descriptive norms were quantified and subsequently classified into five levels based on respondents' actual answers, specifically, "very serious," "relatively serious," "average," "relatively light," and "very light," which corresponded to the numerical scale of 1-5. Directive norms were gauged through the question: "Will others hold individuals accountable for leaving pesticide packaging in the field?" Respondents who answered "yes" were assigned a value of 1, whereas those who responded with "no" were assigned a value of 0.

Moderating Variable: Environmental Regulation. Economic incentives were measured using the question: "Do villagers receive economic rewards for active participation in environmental remediation?" Reputational incentives were assessed with the question: "Are villagers awarded honorary titles for their active participation?" Additionally, financial penalties were measured by inquiring: "Is there a financial penalty for villagers who do not participate effectively?" A " yes " response to the questions above was assigned a numeric value of 1, while a " no " response received a value of 0.

Control Variables. To minimize estimation bias, we introduced control variables encompassing characteristics of household heads (age, education level, health), attributes of households (business scale, part-time involvement, happiness), and factors related to the village (cultivated land area of the village group, cultivated land quality, and village topography) that may have an impact on PPW

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disposal behavior. Detailed information about the variables incorporated into the model and their descriptive statistics is available in Table 1.

Table 1. Variable definition and descriptive analysis.

Variable type		Variable Meaning and Assignment	Average value	Standard deviation
Dependent Variable: Pesticide Packaging Waste Disposal Behavior		Pesticide Packaging Waste Littering Scale: 1 = Frequently Littered, 2 = Occasionally Littered, 3 = Never Littered.	2.692	0.564
Core Explanatory Variable: Social Norms	Descriptive norms	Extent of Pesticide Packaging Litter in Village Fields: 1 = Very Serious, 2 = Serious, 3 = Average, 4 = Minor, 5 = Very Minor.	4.268	0.914
	Directive norms	Social Blame for Abandoned Pesticide Packages: 0 = No, 1 = Yes.	0.624	0.485
Moderating Variable: Environmental Regulation: Incentive regulation	Economic incentives	Are villagers given financial incentives for good participation? 0=No, 1=Yes	0.301	0.459
	Reputational incentives	Financial Incentives for Villager Participation: 0 = No, 1 = Yes.	0.443	0.497
Penalize regulation	Financial penalties	Financial Penalties for Villagers with Subpar Participation: 0 = No, 1 = Yes.	0.252	0.435
Control Variables: Characteristics of Household Heads	Age	Based on Empirical Survey Data (Years).	53.716	14.402
	Education level	Educational Attainment Categories: 1 = Elementary School and Below, 2 = Junior High School, 3 = High School/Middle School/Technical School, 4 = University College, 5 = Bachelor's Degree and Above.	1.774	0.929
Attributes of households	Health	1=very unhealthy, 2=unhealthy, 3=fair, 4=healthy, 5=very healthy	3.659	0.981
	Business scale	Based on Empirical Survey Data (Hectares).	0.341	1.037
	Part-time involvement	Non-farm labor force/labor force (%)	0.154	0.279
	Happiness	Happiness Rating Scale: 1 = Very Unhappy, 2 = Unhappy, 3 = Average, 4 = More Happy, 5 = Very Happy.	4.218	0.860
Factors related to the village	The cultivated land area of the village group	Based on Empirical Survey Data (Hectares).	84.661	73.857
	Cultivated land quality	Arable Land Fertility Assessment: 1 = Very Poor, 2 = Poor, 3 = Fair, 4 = Good, 5 = Very Good.	3.812	0.848
	Mountainous terrain	0 = No, 1 = Yes.	0.366	0.482

 doi:10.20944/preprints202310.0218.v1

(Plains reference)			
Hilly terrain (Plains reference)	0 = No, 1 = Yes.	0.545	0.498

4. Results and Discussion

4.1. Direct Influence of Social Norms on Pesticide Packaging Waste Disposal Behavior

The results of the Ordered Logit model estimation are presented in Table 2. All P-values associated with the model have passed the 1% significance test, indicating the appropriateness of the model selection. As observed in Model (1), which does not include control variables, both descriptive and directive norms exhibit a positive and statistically significant influence on the littering of PPW at the 1% significance level. Model (2), after adding control variables to model (1), the regression coefficients of descriptive and directive norms on the littering of PPW increased but were generally positive and significant at the 1% level. The research findings reveal a significant and positive impact of SNs on RHs' PPW disposal behavior. More specifically, an increase in descriptive norms is linked to a decreased likelihood of RHs littering PPW. With directive norms, RHs are more likely not to litter pesticide packaging waste, verifying hypotheses H1 and H2.

Table 2. Benchmark regression results of social norms on the treatment of pesticide packaging waste.

	Model (1)	**Model (2)**
Descriptive norms	0.435***	0.296***
	（0.101）	（0.113）
Directive norms	0.781***	0.766***
	（0.196）	（0.205）
Age		-0.018**
		（0.009）
Education level		-0.139
		（0.120）
Health		0.251**
		（0.110）
Business scale		-0.248***
		（0.078）
Part-time involvement		0.118
		（0.371）
Happiness		-0.363***
		（0.129）
The cultivated land area of the village group		-0.004***
		（0.001）
Cultivated land quality		0.515***
		（0.143）
Mountainous terrain (Plains reference)		-0.093
		（0.402）
Hilly terrain (Plains reference)		-0.362
		（0.355）
Prob> chi2	0.000	0.000
R^2	0.042	0.103
Obs	574	574

Note: Significance levels are represented as *, **, and ***, indicating statistical significance at the 10%, 5%, and 1% levels, respectively. Standard errors are provided in parentheses for reference.

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It is important to note that in the context of the nonlinear model, the regression coefficients do not inherently represent the marginal effects of the parameters. To provide a more accurate assessment of the variables' impact on RHs' PPW disposal behavior, we conducted an analysis of the estimated coefficients for each parameter in Model (2). The resulting marginal effects are presented in Table 3. Both descriptive and directive norms substantially and positively impact RHs' PPW disposal behavior. Specifically, for each unit decrease in the incidence of village pesticide packaging littering in the field, the likelihood of RHs refraining from littering PPW increases by 4.9%. Conversely, the probabilities of frequent and occasional littering decreased by 1.4% and 3.5%, respectively. When the surrounding people blamed the phenomenon of pesticide package disposal in the field, the probability of RHs refraining from littering PPW increased by 12.6%. Simultaneously, the probabilities of occasional littering and frequent littering decreased by 9.0% and 3.6%, respectively. One possible explanation for this phenomenon is the RHs' limited educational background, which often results in a lack of cognitive and behavioral understanding of ecological protection. Additionally, they commonly assume that the majority's behavior is appropriate. Consequently, when RHs observe those in their vicinity refraining from littering PPW, they are inclined to mimic this conduct to cultivate a positive self-image through conformity with SNs. This tendency can be attributed to the herd mentality. Rural China is characterized by relatively closed social dynamics, marked by a pattern of interpersonal relations often described as "head up, no see, head down, see." Within this context, RHs emphasize the goodwill and recognition of their immediate social circles. They actively work to enhance their reputation by earning favorable evaluations from others. This behavior stems from their desire to avoid social isolation resulting from non-compliance with group standards, which compels them to conform and "fit in." In summary, the necessity to evade social isolation due to deviations from group norms compels farmers to align with the majority's opinion. Consequently, directive norms are pivotal in encouraging farmers not to litter pesticide packaging waste.

Table 3. The marginal effect of social norms on the treatment of pesticide packaging waste.

Variable	Model (3) Often littering	Model (4) Occasional littering	Model (5) Never littered
Descriptive norms	-0.014**	-0.035***	0.049***
	（0.006）	（0.013）	（0.018）
Directive norms	-0.036**	-0.090***	0.126***
	（0.011）	（0.023）	（0.033）
Age	0.001**	0.002**	-0.003**
	（0.0004）	（0.001）	（0.001）
Education level	0.007	0.016	-0.023
	（0.006）	（0.014）	（0.020）
Health	-0.012**	-0.030**	0.041**
	（0.005）	（0.013）	（0.018）
Business scale	0.012***	0.029***	-0.041***
	（0.004）	（0.009）	（0.012）
Part-time involvement	-0.006	-0.014	0.020
	（0.018）	（0.044）	（0.061）
Happiness	0.017**	0.043***	-0.060***
	（0.007）	（0.015）	（0.021）
The cultivated land area of the village group	0.0002**	0.0004***	-0.0006***
	（0.0001）	（0.0002）	（0.0002）
Cultivated land quality	-0.024***	-0.061***	0.085***
	（0.008）	（0.016）	（0.023）
Mountainous terrain(Plains reference)	0.004	0.011	-0.015
	（0.019）	（0.047）	（0.066）
Hilly terrain(Plains reference)	0.017	0.043	-0.060

 doi:10.20944/preprints202310.0218.v1

	（0.017）	（0.042）	（0.058）
Obs	574	574	574

Note: *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively; the numbers reported before the * sign are the marginal effects of the explanatory variables in the Ordered Logit model, and standard errors are in parentheses.

Further analysis reveals that the impact of surrounding group supervision (directive norms) on RHs' tendency to refrain from littering PPW is more significant compared to the influence of the surrounding group's behavior (descriptive norms). This observation suggests that, for RHs, the perception of the surrounding group carries greater informative weight than the group's actual conduct. Rural China is characterized by a strong sense of community. RHs with long-established roots in a specific area typically have limited social networks that predominantly consist of interactions with relatives and friends. For these RHs, maintaining social capital by garnering recognition and respect from their community takes precedence over other considerations. Moreover, RHs tend to adhere to more conservative thought patterns deeply influenced by traditional Confucianism, which places significant emphasis on group orientation and interpersonal relationships. This profound influence extends to daily behavior, where most of the population's value judgments serve as a critical code of conduct.

4.2. Robustness Tests

In order to further verify the robustness of the regression results, this study employs a technique involving substituting the dependent variable and constraining sample characteristics for conducting a robustness test. The outcomes of this test are presented in Table 4.

Table 4. Results of the robustness test on the disposal of pesticide packaging waste by social norms.

Variable	Whether to litter pesticide packaging waste Model (6)	Pesticide Packaging Waste Disposal Behavior Model (7)
Descriptive norms	0.276**	0.262*
	（0.114）	（0.150）
Directive norms	0.716***	0.827***
	（0.209）	（0.274）
Age	-0.012	0.019
	（0.009）	（0.014）
Education level	-0.158	-0.116
	（0.125）	（0.150）
Health	0.299***	0.293**
	（0.114）	（0.146）
Business scale	-0.290***	-0.291***
	（0.097）	（0.087）
Part-time involvement	0.189	-0.328
	（0.379）	（0.458）
Happiness	-0.330**	-0.477**
	（0.129）	（0.209）
The cultivated land area of the village group	-0.005***	-0.004***
	（0.001）	（0.002）
Cultivated land quality	0.502***	0.604***
	（0.145）	（0.202）
Mountainous terrain (Plains reference)	-0.113	-0.202
	（0.416）	（0.517）
Hilly terrain (Plains reference)	-0.345	-0.582
	（0.368）	（0.438）

 doi:10.20944/preprints202310.0218.v1

Prob> chi2	0.000	0.000
R^2	0.122	0.144
Obs	574	574

Note: Significance levels are represented as *, **, and ***, indicating statistical significance at the 10%, 5%, and 1% levels, respectively. Standard errors are provided in parentheses for reference.

1. Replace the dependent variable. Based on the distribution of dependent variable scores, we categorized 1-point and 2-point samples as the "littering" group, assigning them a value of 0. Conversely, 3-point samples were categorized as the "not littering" group, assigned a value of 1, resulting in the creation of the new dependent variable "Whether to litter pesticide packaging waste." This new dependent variable was employed in a binary logit model regression, and the regression outcomes are presented in the model (6). Overall, the estimation results of the binary logit model exhibit substantial consistency with those of the ordered logit model, confirming the robustness of the research findings.

2. Restriction of Sample Characteristics. Advanced age among RHs may limit their active involvement in agricultural production. Consequently, individuals aged over 60 are excluded from the sample. Subsequently, while controlling for household head, family, and village characteristics, the Ordered Logit regression is re-executed, and the outcomes are presented in the model (7) within Table 4. It is evident that the regression results in the model (7) align closely with those obtained from the full sample, underscoring the robustness of the study's findings.

4.3. Addressing endogeneity

Within the context of a rural community characterized by close-knit relationships, the disposal of PPW and monitoring behaviors are not random occurrences. Individual actions are apt to shape the behavioral choices of other community members, potentially introducing endogeneity issues into the baseline regression. To address this concern, we have employed "neighborhood" as an instrumental variable for SNs. There are several compelling justifications for the suitability of instrumental variables: Firstly, macro-level neighborhoods are highly exogenous to RHs' disposal of PPW. Secondly, neighborhoods exhibit a robust correlation with both descriptive and directive norms. Furthermore, the stronger the emotional connection among RHs, their willingness to engage in collectively and authentically advantageous actions increases. The preceding study employed an Ordered Logit model to assess the impact of SNs on PPW disposal behavior. However, due to technical feasibility constraints, it was not feasible to directly estimate this effect using the instrumental variables method for the ordered regression model. Consequently, this paper employs the Two Stage Least Squares (2SLS) method to tackle potential endogeneity in the model.

Table 5 presents the estimation results obtained through 2SLS. Prior to conducting the 2SLS estimation of the model, the Hausman test is conducted. This test yields two measures of endogeneity assessment: the p-value of Durbin (score) and the Wu-Hausman test, which stand at 0.096 and 0.099, respectively. These results signify that both descriptive and directive norms are deemed endogenous explanatory variables at the 10 percent significance level, thus validating the necessity for 2SLS estimation. In the assessment of weak instrumental variables, the descriptive norm's Shea's Partial R2 is less than 0.03, while the one-stage F-value stands at 10.209, surpassing the critical value of 10. Similarly, for the directive norm, Shea's Partial R2 is under 0.04, but the one-stage F-value is 21.519, exceeding the critical value of 10 as well. Therefore, we reject the initial hypothesis of the existence of weak instrumental variables. In the first-stage regression results of the SLS estimation, it is evident that neighborhood relationships reduce PPW littering among community members and enhance the likelihood of oversight by others. In the subsequent second-stage regression, the coefficients for descriptive and directive norms are significantly positive, consistent with the baseline regression results, affirming their significance even after addressing the endogeneity issue.

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Table 5. Estimation results of endogenous processing (2SLS method).

Variant	Model (8)Descriptive norms		Model (9)Directive norms	
	First phase	Second phase	First phase	Second phase
Descriptive norms		0.338* （0.189）		
Directive norms				0.589** （0.288）
Instrumental variable：				
Neighborly relations	0.196*** （0.061）		0.124*** （0.027）	
Control Variables	Containment		Containment	
Shea's Partial R^2	0.028		0.033	
Phase I F-value	10.209		21.519	
Durbin (score) test p-value	0.096		0.096	
Wu-Hausman test p-value	0.099		0.099	
Obs	574		574	

Note: Significance levels are represented as *, **, and ***, indicating statistical significance at the 10%, 5%, and 1% levels, respectively. Standard errors are provided in parentheses for reference.

4.4. Moderation effects test

In order to test the moderating role of environmental regulation in the role path of SNs and PPW disposal behavior, this study conducts a mechanistic examination by introducing interaction terms involving two regulatory factors: incentive regulation and penalty regulation, in conjunction with SNs, into the initial model. The test outcomes are presented in Table 6.

Table 6. Estimation results of endogenous processing (2SLS method).

	Incentive regulation				Penalize regulation	
	Economic incentives		Reputational incentives		Financial penalties	
	Model (10)	Model (11)	Model (12)	Model (13)	Model (14)	Model (15)
Descriptive norms	0.042** （0.020）		0.032 （0.021）		0.070*** （0.020）	
Directive norms		0.128*** （0.036）		0.074* （0.039）		0.111*** （0.036）
Economic incentives	0.082 （0.198）	0.128** （0.061）				
Reputational incentives			0.021 （0.159）	0.089* （0.051）		
Financial penalties					0.447** （0.181）	0.118* （0.069）
Descriptive norms * Economic incentives	0.009 （0.046）					
Directive norms * Economic incentives		-0.014 （0.084）				
Descriptive norms * Reputational incentives			0.035 （0.038）			
Directive norms * Reputational incentives				0.137* （0.072）		

 doi:10.20944/preprints202310.0218.v1

Descriptive norms *					-0.079*	
Financial penalties					（0.043）	
Directive norms *						0.019
Financial penalties						（0.089）
Control Variables	Containment	Containment	Containment	Containment	Containment	Containment
Prob> chi2	0.000	0.000	0.000	0.000	0.000	0.000
PseudoR2	0.115	0.111	0.104	0.103	0.119	0.115
Obs	574	574	574	574	574	574

Note: *, **, **** indicate significant at the level of 10%, 5%, and 1%, respectively. The figures reported before the * are the marginal effects of each explanatory variable in the Ordered Logit model when the pesticide packaging waste treatment "behavior = 3" and the standard error in parentheses.

Firstly, we examine the moderation effect of economic incentives on the relationship between descriptive norms and PPW disposal behavior. As demonstrated in Model 10 of Table 6, descriptive norms exhibit a significant positive impact on PPW disposal behavior. However, the coefficients related to incentive regulation and the interaction term are non-significant. It indicates no moderating effect of economic incentives in the pathway between descriptive norms and PPW disposal behavior and rejects Hypothesis H3. One plausible explanation is that when RHs opt for PPW recycling, it results in increased labor input and higher production costs. Given the current state of imperfect incentive regulation, the rewards offered primarily consist of low-value household items, which fail to offset the heightened capital investments made by RHs. So, there is no moderating effect of incentive regulation.

Secondly, we examine the moderation effect of economic incentives on the relationship between directive norms and PPW disposal behavior. As demonstrated in Model 11 of Table 6, upon introducing the moderating term for directive norms and economic incentives, both directive norms and economic incentives exhibit a significant positive influence on PPW disposal behavior. However, the coefficient associated with the interaction term is non-significant, suggesting the absence of a moderation effect of economic incentives in the pathway between directive norms and PPW disposal behavior, thereby leading to the rejection of Hypothesis H4. One plausible explanation for this phenomenon is that economic incentives, primarily targeting individual RHs by offering financial rewards to those who refrain from littering PPW or engage in recycling, typically do not extend rewards to the social group responsible for monitoring activities. This lack of incentives fails to motivate the social group to engage in monitoring, thus negating any moderation effect.

Thirdly, we explore the moderation effect of reputation incentives on the relationship between descriptive norms and PPW disposal behavior. As evident from Model 12 in Table 6, upon introducing the moderating terms for reputation incentives, descriptive norms, and reputation incentives themselves, none of these variables exhibit statistical significance. This suggests the absence of a moderation effect of reputation incentives in the context of descriptive norms and PPW disposal behavior, leading to the rejection of Hypothesis H5. One plausible explanation for this phenomenon is that honorary titles are typically conferred upon individuals exhibiting exceptional behavior, primarily those engaged in large-scale farming activities. When the broader social group demonstrates a tendency not to litter PPW, it becomes challenging for small-scale RHs to emulate this behavior and consequently receive rewards. Moreover, in rural societies where small-scale RHs predominate, reputation incentives struggle to influence the behavior of the majority of RHs, leading to the absence of a moderation effect.

Fourthly, we explore the moderation impact of reputational incentives on the relationship between directive norms and PPW disposal behavior. As demonstrated in Model 13 of Table 6, directive norms exhibit a significant positive influence on PPW disposal behavior, and reputational incentives also demonstrate a significant positive effect on this behavior. Additionally, the coefficients associated with the moderating terms of directive norms and reputational incentives are both positive and statistically significant. This suggests that reputational incentives enhance the promotional effect of directive norms on RHs, encouraging them not to litter PPW, thereby

confirming Hypothesis H6. Rural China embodies a quintessential acquaintances-based society. Following RHs' adherence to directive norms and the ensuing benefits derived from informal communication, the honorary titles conferred by grassroots governance entities serve a dual purpose. They fulfill RHs' lofty aspirations for prestige and respect and mitigate the psychological burdens associated with increased capital investments, thus augmenting their spiritual well-being.

Fifthly, we investigate the moderation effect of punishment regulation on the relationship between descriptive norms and PPW disposal behavior. As demonstrated in Model 14 of Table 6, descriptive norms exhibit a significant positive influence on PPW disposal behavior. Additionally, punishment regulation also displays a significant positive effect on this behavior, suggesting that the implementation of corresponding punishment regulations can deter RHs from engaging in PPW littering. Notably, the interaction term between descriptive norms and punishment regulation is significantly negative, indicating that punishment regulation hampers the ability of descriptive norms to promote RHs' non-littering behavior concerning PPW. This evaluation serves to test Research Hypothesis H7. During the policy development process, the initial purpose of penalty regulations was to encourage RHs to refrain from littering PPW. However, the implementation of these policies, along with the design of their original intent, may have led to excessive behavioral control, resulting in RHs' resistance to the policies. This resistance, in turn, contributed to RHs' psychological opposition to SNs.

Sixthly, we explore the moderation effect of punishment regulation in the pathway of directive norms and PPW disposal behavior. As evident from Model 15 in Table 6, with the inclusion of the moderating term involving directive norms and punitive regulation, both directive norms and punitive regulation coefficients remain positive and significant. However, the interaction term no longer demonstrates significance, suggesting the absence of a moderation effect of punitive regulation on the relationship between directive norms and PPW disposal behavior. This leads to the rejection of Hypothesis H8. One plausible explanation for this phenomenon is that directive norms primarily rely on social groups to assign blame, provide oversight, and impose constraints on RHs' behavior. In contrast, the authority to enforce punishment regulations lies within administrative bodies, and social groups lack the power to penalize arbitrary PPW disposal. Moreover, the decentralized nature of agricultural operations poses challenges for administrative bodies to effectively monitor the arbitrary disposal of PPW. These factors contribute to the ineffectiveness of punishment regulations and their inability to complement directive norms in achieving significant results in PPW management among RHs, ultimately resulting in a lack of moderation effect.

5. Main Conclusion and Policy Implication

5.1. main conclusion

This study utilizes a dataset of 574 rural households （RHs） from Jiangxi Province. We employ the Ordered Logit model, Two-Stage Least Squares (2SLS) analysis, and moderation effect techniques to investigate the underlying mechanisms linking social norms (SNs) with RHs' pesticide packaging waste (PPW) disposal behaviors. We also examine how these impacts vary among RHs with different characteristics. Additionally, we assess the moderating role of environmental regulation in influencing the relationship between SNs and RHs' PPW disposal behaviors. The study's findings indicate that: (1) In the baseline regression analysis, a one-unit decrease in descriptive norms is associated with a 4.9% increase in the likelihood of RHs refraining from littering PPW. Additionally, the probability of often and occasional littering decreases by 1.4% and 3.5%, respectively. Conversely, with regard to directive norms, a 12.6% increase in the probability of RHs never littering PPW is observed, along with a 3.6% decrease in the likelihood of often littering and a 9.0% decrease in occasional littering. These results suggest that both descriptive and directive norms play a role in discouraging RHs from littering PPW. However, crowd monitoring (directive norms) 's influence is more pronounced than crowd behavior (descriptive norms). Notably, these conclusions remain consistent following robustness tests and endogeneity treatments. (2) The findings from the moderation effect analysis reveal significant results: In the context of incentive regulation, the

interaction term between directive norms and reputational incentives is notably positive. Conversely, under the scope of punishment regulation, the interaction term between descriptive norms and punishment regulation is significantly negative. These outcomes indicate that reputational incentives enhance the promotional impact of directive norms on RHs refraining from littering PPW, whereas punitive regulation impedes the promotional influence of descriptive norms on RHs' PPW disposal behavior.

5.2. policy implication

Within the framework of environmental regulation-driven governance, it is imperative to enhance the impact of environmental regulation on RHs' choices regarding PPW disposal behavior and acknowledge the significance of SNs. Coordinate the relationship between social norms and environmental regulation in rural environmental governance and ultimately build a benign comprehensive interaction mechanism based on the economic incentives of environmental regulation, supplemented by the correction of social norms. The recommendations are:

(1) Actively cultivate social norms and give full play to their facilitating role in the choice of pesticide packaging waste disposal behavior of RHs. In China's rural areas, SNs have a more superior nature than environmental regulations, and we should appropriately screen, integrate, and improve the content of SNs and strengthen the shaping and publicity of SNs in line with ecological values; we should give full play to the interconnectedness and mutual reinforcement between descriptive and directive norms, and together we can promote the continuous functioning of SNs, and cultivate good social soil and atmosphere for the corrective role of environmental regulations. Social soil and atmosphere for the role of corrective environmental regulation.

(2) Enhance the effectiveness of environmental regulations in governing RHs' decisions regarding PPW disposal. This can be achieved by refining the methods and mechanisms of public awareness campaigns and technical training to minimize the imposition on RHs' time and mobilization expenses. Furthermore, it is imperative to recalibrate subsidy approaches and the subsidy framework for incentive-based regulations. Simultaneously, it bolsters environmental oversight of subsidized farmers and fortifies the development of constraint-based regulations.

(3) Facilitating the harmonization of environmental regulations and SNs is essential. To achieve this, we should devise and enhance environmental regulations that align with the specific stage of rural development and local SNs. Additionally, it is prudent to allocate subsidies primarily to rural regions characterized by robust social cultures and strong SNs. This approach allows for the utilization of SNs in refining environmental regulations and establishing a model of sustainable green development.

Author Contributions: Conceptualization, Yuhan Zhang and Xueping Gao; methodology, Mengling Zhang and Zhenlin Weng; software, Yuhan Zhang and Mengling Zhang; validation, Yuhan Zhang, Mengling Zhang and Wenmei Liao; formal analysis, Yuhan Zhang; investigation, Wenmei Liao; resources, Wenmei Liao; data curation, Mengling Zhang; writing—original draft preparation, Yuhan Zhang; writing—review and editing, Mengling Zhang; visualization, Xueping Gao; supervision, Wenmei Liao; project administration, Wenmei Liao; funding acquisition, Xueping Gao. All authors have read and agreed to the published version of the manuscript. Mengling Zhang and Yuhan Zhang contributed equally to this work and should be regarded as co-first authors.

Funding: This research was funded by the NATIONAL NATURAL SCIENCE FOUNDATION OF CHINA, grant number 71763012, and JIANGXI PROVINCIAL DEPARTMENT OF EDUCATION SCIENCE AND TECHNOLOGY RESEARCH PROJECT, grant number GJJ180192.

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: The data presented in this study are available on request from the corresponding author.

Acknowledgments: We wish to thank Xu Zhang and Danting Wang for their advice on the English writing.

Conflicts of Interest: The authors declare no conflict of interest.

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