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Alexandra M. Pyan Date

The Association of C - reactive protein and Alpha-1-acid-glyoprotein with Reported Acute Illness Outcomes in Preschool Children in Western Kenya

By

Alexandra M Pyan

Master of Public Health

Epidemiology

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Kevin M Sullivan, PhD, MPH, MHA

Committee Chair

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B.A, St. Olaf College, 2009

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An abstract of

A thesis submitted to the Faculty of the
Rollins School of Public Health of Emory University
in partial fulfillment of the requirements for the degree of

Master of Public Health
in Epidemiology

2014

Abstract

The Association of C - reactive protein and Alpha-1-acid-glyoprotein with Reported Acute Illness Outcomes in Preschool Children in Western Kenya

Alexandra M Pyan

Study Design: Cross-sectional

Objective: To establish the association between inflammation biomarkers, C-reactive protein (CRP) and α-1-acid-glycoprotein (AGP), and reported acute illness outcomes in preschool children in a region with high levels of malnutrition and endemic infectious disease.

Research Design and Methods: In a population-based, cross-sectional study of 849 children aged 6-35 months in Nyando Division, Western Kenya, we measured CRP, AGP, hemoglobin, anthropometry, socioeconomic status, both blood smear and self-reported malaria, fever, and diarrhea. Prevalence odds ratios for acute illness outcomes (malaria, diarrhea, fever, and any of the three) were determined using logistic regression with the exposures of elevated CRP, elevated AGP and either elevated CRP or AGP.

Results: The strongest observed associations were with malaria and elevated CRP (POR: 7.7; 95% Confidence Interval 5.2, 11.4) and elevated AGP (7.7; 5.1, 11.52); as well as either elevated CRP or AGP (8.1; 5.2, 12.4). All unadjusted bivariate associations with the three exposures and acute illness outcomes were statistically significant. The association between elevated CRP and fever had effect modification by age and was stratified into three age categories while also controlling for breastfeeding status and stunting. The association for either elevated CRP or AGP and fever had effect modification by breastfeeding status. No other confounders or effect modifiers were found to be significant in any of the models.

Conclusions: Overall we observed strong associations between malaria and the biomarkers of inflammation. The population had a high prevalence of acute illness with 54.9% reporting at least one of the selected outcomes and 5.9% reported all three. All models were significant indicating a strong association between reported acute illness and CRP and AGP. Due to these associations these inflammation biomarkers have the potential to reflect the burden of acute disease in the population.

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Finally, a special thanks to my family who have always supported my dreams and adventures without question. Especially to my parents who fostered my sense of curiosity and love of learning.

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Chapter I: Literature Review

Children living in many parts of the developing world are repeatedly exposed to multiple infectious diseases and can have high prevalence of acute illness including fever respiratory illness and diarrhea. This repeated exposure to infectious pathogens can lead to chronic inflammation that may impair growth and contribute to anemia (1). Two important biomarkers of both acute and chronic inflammation are C-reactive protein (CRP) and α1-acid glycoprotein (AGP); both of which are positive active acute phase proteins and commonly measured in population-based surveys (2, 3).

The acute phase reaction (APR) is a short term metabolic change that is part of the innate immune system and occurs in response to the presence of pathogens or damaged cells within the body (1, 3). The APR is characterized by the changes that occur away from the site of injury or infection and can involve many organs and is usually accompanied by inflammation (2). Inflammation is defined as the biologic response of vascular tissues to stimuli such as pathogens or damaged cells and results in response throughout the body (3). The acute phase response facilitates the restoration of hemostasis following injury or infection (4). Both CRP and AGP are positive acute proteins (APPs) which means that their concentrations increase at by least 50 percent during the inflammatory process (2). CRP and AGP are considered type I APPs and have a proinflammatory response (4). Because of this distinctive characteristic, APPs can be used as indicators for the acute phase response within an individual, which is generally used as a proxy to determine the presence of inflammation in individuals. Not all acute phase proteins increase uniformly in individuals with the same illness and different APPs are activated at different phases of the response (1). The acute phase

response can also be marked by the induction of fever, the increased synthesis of hormones, including ACTH and hydrocortisone, and increased leukocytosis (1). Multiple factors are known to affect an individual's acute phase response including genetics and environmental factors. The APP has also been shown to have a diminished response in severely malnourished children, undernourished adults and asymptomatic individuals with HIV-1(1, 5).

CRP has historically been a widely used marker for inflammation in both acute and chronic inflammation (6-8). Inflammation is triggered by a stimuli response such as injury to cells or presence of a pathogen in the body (7). Following a trigger, CRP levels have been shown to increase up to 1000 fold their baseline levels in a healthy individual. Because CRP levels can rise from 1 mg/l to as high as 600-1000 mg/l in a short period, it is considered to be a classical acute phase protein (6). CRP levels typically begin to rise within 6 hours of the stimuli and will typically reach their maximum levels around 48 hours (7, 8). Once the stimulus is gone the level of CRP falls dramatically and the plasma half-life of CRP is about 19 hours (8). CRP is primarily synthesized and secreted by the heptocyctes of the liver and is regulated by inflammatory cytokines, interleulin-6 (IL-6) in particular (9). IL-1, glucocorticoids and complement activation products have also been found to promote the effects of IL-6 on CRP levels(10).

First discovered in 1930, CRP was named because of its ability precipitate the somatic C-polysaccharide of *Streptococcus pneumonia* and was the first acute phase protein to be described (8). It is a member of the pentraxin family of proteins and has Ca^{2+}-dependent binding specificity for phosphocholine, which is a component of many bacterial and fungal polysaccharides (10). CRP has been found to be a good biomarker

for the screening of disease, monitoring the effectiveness of treatment for inflammation and infection, and the detection of infection in immunocompromised individuals (8).

CRP binds to the surface of bacterial and damaged host cells and activates the complement system to facilitate phagocytosis (11). The main biological function of CRP appears to be a host defense against bacterial pathogens and the clearance of apoptotic and necrotic cells which contributes to the restoration of injured tissues(10). Bacterial infections have been shown to elevate levels of CRP higher than what is observed with viral infections (7). The literature also suggests that CRP levels tend to be higher in those with more severe cases when compared to mild cases of the same infection (12, 13). While CRP is part of the innate immune system it also plays role as an adaptor as part of the adaptive immune system (6).

Baseline CRP levels are thought to be at least partially heritable (8). Other factors that are known to influence CRP levels include BMI, diabetes, gender, socioeconomic status, and insulin resistance (8, 14). Obesity is considered to be a systemic inflammatory disease and those who are obese or overweight, both adults and children, have been found to have elevated CRP levels (7).

A study of healthy young adults in the United States found the median level of CRP to be .8 mg/l and the 90^{th} percentile to be 3.0 mg/l; 10 mg/l was the 99^{th} percentile which has become a commonly used cut-off to indicate the active phase response (8). CRP levels change drastically over the course of an illness and the range for abnormal levels can be quite broad (1). The cutoff of 5 mg/l for CRP was primarily based on levels

observed with coronary heart disease in adults and has recently been lowered to 3 mg/l to determine presence of low-grade, chronic inflammation (15).

Multiple studies have looked at different cut-off points for both CRP and Alpha-1 acid glycoprotein (AGP), and there not a universally agreed upon level for clinical purposes (2, 3, 8). But the most widely used cut-off for CRP is 5 mg/l to indicate activation of acute phase and 1 mg/1 for AGP (2, 9). These are cut-offs we will be using in our study.

Alpha-1 acid glycoprotein (AGP), or orosomucid, is a less understood acute phase protein (16). Like CRP, its levels greatly increase during the acute phase response but this generally occurs later in the process then the rise of CRP. It is unusual to see a rise in AGP before 48 hours after stimulation of the acute phase response occurs and the maximum concentrations occur 4-5 days into the process (15). The serum concentrations of AGP increases about 2 to 5 fold the baseline levels at its peak concentration (17). AGP was first described in 1950 by Karl Schmid and Richard J Winzler and has a high carbohydrate content of more the 40% (16). It is a member of the immunocalin family, a sub-family of the lipocalin protein family (18). AGP, like CRP, is mainly secreted by heptacytes and is regulated by IL-1, IL-6, IL-8 and glucocorticoids (2). It is also thought to create a positive feed-back loop with IL-1 (17).

The exact biologic role of AGP is still not fully understood but it is thought to have an anti-inflammatory effect and have both anti-neutophil and anti-complement activity (16). AGP has been shown to inhibit several neutrophils and this can help regulate inflammation and potentially reduce the damage caused by neutrophil proteases

and reactive oxygen species (17). Some findings also suggest that AGP can have some positive effects on wound healing (17). Evidence supports that AGP can bind to many basic drugs including quinine, which is used to treat malaria (19). With albumin, AGP is one of the human plasma proteins with largest contribution to serum protein binding of drug (18). During inflammation the concentration of AGP does not only increase, but the structure of the protein also changes and glycosylation occurs (2, 16). Changes in the glycosylation of AGP have also been observed in other instances besides the activation of the acute phase response including pregnancy, severe rheumatoid arthritis, liver cirrhosis and hepatitis (16). Because AGP is elevated during late convalescence, it is often considered to be associated with chronic illness(5).

The association between biomarkers for inflammation and acute illness is not a new concept, and both CRP and AGP have been examined to determine their ability to aid in diagnosis or predict morbidity or mortality of an illness. CPR and AGP can be utilized since concentrations of both can be elevated even if clinical symptoms are not present and can remain elevated even after certain interventions are used (11). CRP levels can be measured using serum, plasma and dried-spot samples (20). Methods applying the ELISA use the readily available monoclonal antibodies to measure CRP from all three sources using venous or capillary blood. Dried blood spot tests have been used for population based studies because they can be efficient and less expensive than serum or plasma testing (20). The use of monocolonal antibodies replaces the dried blood spot test developed by McDade et. al. due to the loss of readily available polycolonal antibodies needed for the procedure (20, 21). Because acute infection needs to accounted for when performing assessment on both Vitamin A and iron status, a

sandwich assay has been developed which allows for simultaneous sampling of ferritin, soluble transferrin receptor, retinol binding protein, CRP, and AGP (22). The sandwich ELISA was found to have no bias when compared to the standard IBL CRP kit. The test is performed using capillary blood from a finger stick collected into a small tube which is easier for use with children. While the original assay developed did not include testing for AGP, its addition was recommended to serve as a more effective correction for chronic illness (22).

CRP has been found to be particularly helpful in distinguishing between bacterial and viral respiratory infections (12, 23). It has been especially useful in distinguishing pneumonia from other upper respiratory tract infections (23). CRP concentrations have been found to be particularly high in those infected with *S pneumonia* and *L pneumophila (12)*. Evidence supports the use of CRP to distinguish between bacterial and viral infections in both immunocompetent and immunosuppressed individuals (24). Adults who have community-acquired pneumonia caused by *S pneumoniae* or *L pneumophila* have been found to have higher CRP levels then in those whose pneumonia was caused by viruses. It has also been suggested that high CRP levels may be suggestive of severity (12).

However, this association is questioned as other research have found no significant difference in CRP levels in children (≤5 years) with viral or bacterial pneumonia in a primary healthcare setting (25). The use of CRP has a diagnostic tool with pneumonia is likely dependent on both the cut-off that is used and the rate of community-acquired pneumonia within that specific community (26). CRP has also been used to distinguish pneumonia from other respiratory infections (23); some research

indicates that levels are higher in those infected with tuberculosis when compared to individuals with other respiratory infections, even among individuals co-infected with HIV (27). Higher CRP levels are also thought to indicate higher mycobacterial loads and those with higher levels are more likely to have the disseminated disease (22). However, CRP is still thought to have a limited diagnostic utility particularly in ruling out TB in HIV-infected individuals before other test results are available.

The association between febrile illness and CRP has also previously been examined; most studies of febrile illness define the presence of fever at 38 or 39 C (28, 29). Research in children under 36 months in the US have found significantly higher CRP levels in febrile children with serious bacterial infections compared to those without (29). CRP levels have also been shown to be a valuable tool for distinguishing bacterial from viral infections in children who have been symptomatic for at least 12 hours (28). However, a high cut-off of 40 mg/l was used and children with CRP values between 20-40 mg/l where found in children with both bacterial and viral infections (23). When compared to the standard absolute neutrophil test, no significant advantages to using CRP as an alternative was found (24). Other studies of young children in Tanzania found no significant correlation between fever and CRP or AGP (1). In neutropenic children with febrile episodes , CRP levels, $\geq$ 90 mg/l, were found to be associated with gram-negative bacterium (30).

Another acute illness of concern globally, especially for young children in developing countries, is acute diarrhea. Diarrhea can be the cause of growth faltering and lead to malnutrition in children (1). Inflammation biomarkers such as CRP and AGP could potentially be used to indicate systemic illness and may have an association with

complicated or uncomplicated cases. A study using Tanzanian children, aged 6-25 months, found that a high proportion (86%) of children with acute diarrhea had a current acute phase response (1). They found that CRP was the best marker for systemic infection and found no significant relationship when AGP was used as an indicator. While the biomarkers may not always accurately indicate the presence of systemic infection, they can be used to help differentiate between inflammatory and non-inflammatory diarrhea. However, there is the concern that the presence of malnutrition may dampen the acute phase response and thus reduce the effectiveness of the APPs as indicators (1).

Of interest in many developing countries, and sub-Saharan Africa in particular, is the association between inflammation markers and malaria. The role of the acute phase proteins during malaria is still unclear but CRP does bind to erythrocytes infected by *Plasmodium falciparum* which results in their clearance by humoral and cellular immune mechanisms (31). A significant association has been found between level of parasitism, the pre-treatment counts of parasites, and the levels of both CRP and serum amyloid A protein, another acute phase protein in individuals who are positive for malaria (32). The degree of parasitism is known to correlate with the severity of disease and CRP levels thus have the potential to help provide early diagnosis of severe cases of malaria. Currently severity is typically assessed using a combination of clinical observations and laboratory markers (32). Some literature also suggest that the acute phase response occurs differently in those who have chronic exposure to malaria and have developed immunity compared to no immunity (33). Those with immunity are thought to have smaller increases in CRP levels (33).

Serum concentrations of CRP typically fall after the start of anti-malarial therapy and parasite levels decrease (32). A larger study conducted in children in Papua New Guinea found lower CRP concentrations in the patients with the most severe malaria. The investigators hypothesized that CRP may have a role in protection against infection and tissue repair since it binds to the phosphocholine present in the membranes of damaged and necrotic cells resulting in their clearance by the complement system and phagocytosis (31). Lower CRP levels in more severe and fatal cases suggest that the failure to control inflammatory response may contribute to the progression of severe disease (31).

Less is known about the association between AGP and malaria. However, it is known that AGP plays a role in the binding of quinine in the body and the degree to which quinine binding occurs correlates strongly with the concentration of AGP in both those with malaria and healthy controls (19). Although, unlike CRP, there does not appear to be an association between parasite density and AGP (19). Some evidence suggests that with acute infections of *Plasmodium falciparum* serum concentrations of AGP increase about two-fold within 24 hours of infection in non-immune individuals (18).

Among individuals infected with HIV, CRP is known to have a prognostic role in the diagnosis of opportunistic infections. Chronic viral infections are not thought to cause an acute phase response (34). Individuals with HIV can have an acute phase response even in the absence of secondary infections, although not all APPs are thought to be elevated and the levels tend to be lower then what is seen with acute bacterial infections (34). There is some evidence that individuals with HIV-1 may have impaired

ability for their acute phase response and that levels of positive acute phase proteins may not be elevated as high as in non-infected individuals (34). HIV is known to cause chronic inflammation and in the absence of any other inflammation stimuli, infected individuals are characterized by high inflammatory biomarkers then non-infected individuals (35).

Inflammation can result in hypoferremia and can led to anemia, especially in children (33). During acute infection, ferritin increases parallel to CRP but during chronic infections serum ferritin levels are more likely to resemble AGP. Because inflammation can affect the ability to accurately assess iron levels in an individual and thus CRP and AGP levels should be used to make adjustments using a sandwich assay that measures the biomarkers, ferritin, soluble transferrin receptor, and retinol binding protein (22, 33, 36). There is some literature that suggests that AGP alone may be the more accurate biomarker when accounting for inflammation in anemia (33). Plasma retinol, used as an indicator of vitamin A status, is also reduced by the presence of both clinical and subclinical inflammation (5). Vitamin D levels are also known to be affected by inflammation and the inflammatory response begins to affect all of these concentrations within the first 24 hours of infection (37-39). It is recommended at least two acute-phase proteins that respond differently over the course of an infection are measured to account for all stages of subclinical infection when assessing anemia and malnutrition in populations with high levels of chronic acute illness (15). Malnutrition may also trigger APPs and some evidence shows AGP at above normal levels in undernourished subjects (18).

Other factors besides infection or trauma can influence inflammatory biomarker levels as well. Lifestyle factors including: obesity, dietary fiber intake, saturated fat intake, physical activity, smoking, and alcohol intake have all been linked to chronic inflammation and thus can result in increased concentrations of APPs (40). There is some evidence to support that chronic stress, including stress caused by the home and neighborhood environment, may increase inflammation levels in children (41). Prenatal and early nutritional status may also have an impact on an individual's immune system and the level to which they produce APPs (14). Low socioeconomic status as children has been found to be associated with elevated CRP levels in adults and increased proinflammation gene expression (14) . Most of these studies have focused on chronic low-grade inflammation which is defined as CRP > 3 mg/l and thus even if an individual is suffering from this low-grade chronic inflammation their levels will not typically be confused with an actual acute phase response (defined as >5 mg/1) (9, 14, 40, 41).

Adult women are known to express enhanced levels of immunoreactivity which makes them more resistant to infections when compared to men. Overall, women also experience autoimmune diseases at higher levels than men (42). While these differences typically do not manifest until after puberty, girls usually have a better prognosis during an infection then boys. But, when a condition causes chronic inflammation then the situation is reversed with boys having better outcomes (42). This is expressed in CRP levels, of which girls tended to have higher levels than boys with the same infection but it appears that this is only true until a peak CRP level is reached and then the two groups will have similar levels (42). Because of the difference seen in the two genders, gender

should be assessed for both effect modification and confounding when examining inflammation markers.

Chronic low grade inflammation, typically defined as CRP levels ≥ 3 mg/l, is a risk factor for cardiovascular disease, type 2 diabetes, metabolic syndrome and late-life disability (9, 43). It is thought that inflammation may contribute directly to the pathogenesis of athrosclerosis and that CRP may even be part of the causal pathway (43, 44). In areas where acute illness and infection are common place chronic inflammation is more difficult to detect because it can be obscured by the acute phase response (43). When studying acute illness, chronic inflammation does not typically need to be addressed since the cut-off for indication of the APR is far greater, ≥ 5 mg/1, then the cut off of 3 mg/l used for chronic inflammation.

Our study will examine the association between CRP and AGP levels and the reported presence of acute illness in preschool aged children in Western Kenya. There is disagreement in the literature of this association, particularly in regards malaria and we aim to provide added information and further clarification. Malaria, acute respiratory infections and diarrhea are all major causes of morbidity and mortality in the children in the study population (45). This study is a secondary analysis of a larger study that aimed to assess micronutrient levels and establish determinants for anemia in the region. They found anemia to be most strongly associated with malaria, iron deficiency and inflammation (37). Due to the high levels of malnutrition and anemia in the population, a better understanding of inflammation could provide additional insight into addressing these concerns. Ultimately we want to determine if both inflammation biomarkers and acute illness status needs to be collected and evaluated when conducting nutritional

surveys. Establishing the association between the two will allow us to determine if instead of collecting information on acute illness we can use inflammation biomarkers as a proxy. This is especially important in our study population since the reported acute illnesses are likely inaccurate due to the survey relevance on mothers reporting of acute illness which may not be a valid source.

Chapter II:

Manuscript

Abstract

The Association of C - reactive protein and Alpha-1-acid-glyoprotein with Reported Acute Illness Outcomes in Preschool Children in Western Kenya

Alexandra M Pyan

Study Design: Cross-sectional

Objective: To establish the association between inflammation biomarkers, C-reactive protein (CRP) and α-1-acid-glycoprotein (AGP), and reported acute illness outcomes in preschool children in a region with high levels of malnutrition and endemic infectious disease.

Research Design and Methods: In a population-based, cross-sectional study of 849 children aged 6-35 months in Nyando Division, Western Kenya, we measured CRP, AGP, hemoglobin, anthropometry, socioeconomic status, both blood smear and self-reported malaria, fever, and diarrhea. Prevalence odds ratios for acute illness outcomes (malaria, diarrhea, fever, and any of the three) were determined using logistic regression with the exposures of elevated CRP, elevated AGP and either elevated CRP or AGP.

Results: The strongest observed associations were with malaria and elevated CRP (POR: 7.7; 95% Confidence Interval 5.2, 11.4) and elevated AGP (7.7; 5.1, 11.52); as well as either elevated CRP or AGP (8.1; 5.2, 12.4). All unadjusted bivariate associations with the three exposures and acute illness outcomes were statistically significant. The association between elevated CRP and fever had effect modification by age and was stratified into three age categories while also controlling for breastfeeding status and stunting. The association for either elevated CRP or AGP and fever had effect modification by breastfeeding status. No other confounders or effect modifiers were found to be significant in any of the models.

Conclusions: Overall we observed strong associations between malaria and the biomarkers of inflammation. The population had a high prevalence of acute illness with 54.9% reporting at least one of the selected outcomes and 5.9% reported all three. All models were significant indicating a strong association between reported acute illness and CRP and AGP. Due to these associations these inflammation biomarkers have the potential to reflect the burden of acute disease in the population.

Introduction

Micronutrient deficiencies and anemia are major public health problems throughout the world principally in low-resource countries; proper assessment of micronutrients is needed to properly calculate the prevalence of deficiencies and evaluate interventions. Inflammation has been found to affect biomarkers of status, especially in areas with high levels of endemic infectious disease, account for inflammation (46). A number of approaches have been published on how to account for inflammation when estimating micronutrient biomarkers but, there is no general consensus as to which method is most appropriate. Typically inflammation biomarkers are measured and used to make this adjustment (33). One approach is to assess C-reactive protein (CRP) and α1-acid glycoprotein (AGP), which respond at different stages, when assessing malnutrition in populations with high levels of endemic acute illness (15).

CRP has historically been used as a marker for inflammation in both acute and chronic illness (6-8). Following an inflammation trigger CRP levels increase up to 1000 fold their baseline levels in a healthy individual. Because CRP levels can rise from 1 mg/l to as high as 600-1000 mg/l in a short period, it is considered to be the classical acute phase protein (6). This increase is typically occurs within 6 hours of stimuli and maximum levels are reached around 48 hours (7, 8). Once the stimulus is gone the level of CRP falls dramatically and CRP has a plasma half-life of 19 hours (8). CRP is primarily synthesized and secreted by the heptocyctes of the liver and is regulated by inflammatory cytokines, interleulin-6 (IL-6) in particular.

Alpha-1 acid glycoprotein (AGP), or orosomucid, is a less understood acute phase protein (16). Like CRP, its levels greatly increase during the acute phase response but

this generally occurs later in the process. It is unusual to see a rise in AGP before 48 hours after stimulation occurs and the maximum concentrations occur 4-5 days into the process (15). The serum concentrations of AGP increases about 2 to 5 fold the baseline levels at its peak concentration (17).

The association between biomarkers for inflammation and acute illness has been studied before, and both CRP and AGP have been examined to determine their ability to aid in diagnosis or to predict morbidity or mortality of an illness. Concentrations of both can be elevated even if clinical symptoms are not present and can remain elevated even after certain interventions are used (11). CRP has been found to be particularly helpful in distinguishing between bacterial and viral respiratory infections (12, 23). The association between febrile illness and CRP has also previously been examined but the results are mixed (28, 29). One study of children in Tanzania, aged 6-25 months, found no significant correlation between fever and CRP or AGP (1). The same study found that a high proportion (86%) of children with acute diarrhea also had elevated inflammation biomarkers (1). CRP was determined to be the best marker for systemic infection but, found no significant relationship when AGP was used. While the biomarkers may not always accurately indicate the presence of systemic infection, they can be used to help differentiate between inflammatory and non-inflammatory diarrhea. However, there is concern that the presence of malnutrition may dampen the acute phase response and thus reduce the effectiveness of APPs as indicators of acute illness (1).

An association has been documented between the level of parasitism and the levels of CRP in individuals who are positive for malaria (32). The degree of parasitism is known to correlate with the severity of illness and CRP levels thus have the potential to

help provide early diagnosis of severe cases of malaria. A larger study conducted in children in Papua New Guinea found lower CRP concentrations in the patients with the most severe malaria. The investigators hypothesized that CRP may have a role in protection against infection and tissue repair since it binds to the phosphocholine present in the membranes of damaged and necrotic cells resulting in their clearance by the complement system and phagocytosis (31).

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Other factors besides infection or trauma can influence inflammatory biomarker levels as well. Lifestyle factors including: obesity, dietary fiber intake, saturated fat intake, physical activity, smoking, and alcohol intake have all been linked to chronic inflammation and thus can result in increased concentrations of APPs (40). There is some evidence to support that chronic stress, including stress caused by the home and neighborhood environment, may increase inflammation levels in children (41). Prenatal and early nutritional status may also have an impact on an individual's immune system and the level to which they produce APPs (14). Low socioeconomic status as children has been found to be associated with elevated CRP levels in adults and increased

proinflammation gene expression (14) . Women and girls typically have higher levels of CRP than boys and men with the same infection (42).

Our study will examine the association between CRP and AGP levels and the reported presence of acute illness in preschool aged children in Western Kenya. There is disagreement in the literature of this association, particularly in regards malaria and we aim to provide added information and further clarification. Malaria, acute respiratory infections and diarrhea are all major causes of morbidity and mortality in the children in the study population (45). This study is a secondary analysis of a larger study that aimed to assess micronutrient levels and establish determinants for anemia. They found anemia to be most strongly associated with malaria, iron deficiency and inflammation. Due to the high levels of malnutrition and anemia in the population, a better understanding of inflammation could provide additional insight into addressing these concerns. Ultimately we want to determine if both inflammation biomarkers and acute illness status needs to be collected and evaluated when conducting nutritional surveys. Establishing the association between the two will allow us to determine if instead of collecting information on acute illness we can use inflammation biomarkers as a proxy. This is especially important in our study population since the reported acute illnesses are likely inaccurate due to the survey's reliance on mothers reporting acute illness which may not be a valid source.

Methods

Study Population

The study population was recruited from the Nyando Division, Nyanza Province, Kenya. Nyando Division has a population of about 80,000 people, who are of mostly Luo ethnicity and primarily subsistence farmers. Families in the region typically live in compounds with a main house and one to three additional households (37, 47). In the study area 86.1% of families fall within the poorest socioeconomic quintile in Kenya. A 2007 baseline survey found acute respiratory illness in 21.5% and malaria in 19.8% of preschool aged children. Chronic malnutrition was also observed in 28.0% of preschool aged children (47).

A cross-sectional, household based cluster survey of children aged 6-35 months was conducted in August 2010 in 60 villages selected from villages included in the Nyando Integrated Child Health and Education (NICHE) project. NICHE originally evaluated the effectiveness of the promotion and sale of health products, including micronutrient powders, to improve nutritional status and diarrhea morbidity from 2007 to 2010 (47, 48). Two cluster surveys of 30 villages, one cluster of intervention villages and one of control villages, were chosen from different political jurisdictions to limit the influence of one cluster to the other (47). In 2008, following a 1-year evaluation, the intervention was scaled up to all 60 villages.

Within each of the 60 villages 19 compounds were randomly selected using an updated 2010 household census. All children aged 6-35 months within these compounds were eligible to participate in the study. Written informed consent was obtained from all

participating households. Institutional review boards for the Kenya Medical Research Institute and the U.S Centers for Disease Control and Prevention (CDC) approved the original study (37). The secondary data analysis of de-identified data was approved by the Institutional Review Board for Emory University.

A group of 1,079 children were found eligible from the 1,348 assessed. Of the 1,079, 33 refused, 124 were unavailable, and 26 were excluded for other reasons. Another 47 children had to be excluded from analysis due to missing CRP or AGP results, so 849 children were included in final study population (37). Due to missing measurements, the total observations used in each model varied, with 818 being the smallest number included.

A questionnaire was administered by trained field workers to gather demographic and socioeconomic data, child feeding practices, and child morbidity in the previous 24 hours. Height and length were measured using a wooden measuring board accurate to 0.1 cm (Irwin Shorr Productions, Olney, MD) and weight was measured using a digital scale to the nearest 0.1 kg (Seca Corp, Hanover, MD). Capillary blood samples were collected for malaria smears and hemoglobin measurements. Iron, vitamin A, CRP, AGP were tested later using stored samples.

Frozen plasma samples were sent to the VitA-Iron Lab (Willstaett, Germany), and levels of ferritin, transferrin receptor, retinol binding protein, CRP and AGP were measured using a sandwich enzyme-linked immunosorbent assay (22). The thresholds used to indicate abnormal values were: CRP > 5 mg/L, AGP > 1 g/L, Ferritin < 12µg/L, retinol binding protein < 0.7 µmol/L. Hemoglobin was also assessed from the second

drop of blood from the finger using a HemoCue B-Hemoglobin machine (Angelholm, Sweden) and anemia was defined as < 11.0 g/dL and severe anemia as <7.0 g/dL. Malaria was defined as presence of any parasites on the blood smear and read at the CDC laboratory in Kisian, Kenya (37). Fever and diarrhea were determined based on caregiver answers to morbidity questions in the questionnaire administered by trained field workers. Diarrhea was defined as 3 or more loose or watery stools in the last 24 hours and acute respiratory illness as cough or breathing problems in the last 24 hours. Fever was classified as presence of fever in the last 24 hours. Respondents answers were coded as yes, no or do not know.

Statistical Analysis

Statistical analyses were done using SAS 9.3 (SAS Institute Inc., Cary, NC). To determine the prevalence and 95% confidence intervals (CIs) SAS PROC SURVEYFREQ was used to account for the cluster survey design. Each exposure, CRP and AGP, were modeled separately with each outcome (malaria, diarrhea, fever, and any combination of the three) using PROC SURVEYLOGISITC. A combined exposure of any inflammation, either elevated CRP or AGP, was also modeled with the four outcomes. The model with the strongest association was selected to build a multivariate unconditional logistic model. Prevalence odds ratios were determined using the logistic models to determine the strength of the association.

The WHO Child Growth Standards (WHO Anthro, Geneva, Switzerland) were of used to determine z-scores, with underweight being characterized as a weight-for-age score <-2, stunting as a height/length-for-age z-score <-2, and wasting as a weight-for-

height/length z-score <-2. Socioeconomic status was classified using a principal component analysis to categorize households into quintiles within the study population (37, 49). Socioeconomic status was categorized into quintiles using an asset index developed using Principle Component Analysis.

Multivariate modeling approach

Twelve bivariate logistics models were used to explore the relationship between the four acute illness outcomes (malaria, fever, diarrhea, and any of the three) and the two measured biomarkers of inflammation (CRP and AGP) as well as the presence of any inflammation (either elevated CRP or AGP). From these models the strongest, and most significant, association was selected to create a multivariate model to account for potential covariates.

The model using any inflammation as the primary exposure and positive malaria blood smear was selected to build a multivariate model. The covariates assessed for use in the multivariate model were: socioeconomic status, gender, child age, maternal age, child stunting, child wasting and current breastfeeding status. Child age was categorized into three categories: $6 \geq$ and < 12 months, $12 \geq$ and <24 months, $24 \geq$ and ≤ 35 months. Iron, anemia, and Vitamin A status were not included in the model because inflammation is likely an intermediate in the causal pathway between illness and these outcomes. The covariates were assessed for effect modification by using likelihood ratio tests and backward elimination to determine if interaction terms were significant, defined by P-value <0.05. Confounding was assessed using the all possible subsets method and the covariates were retained if dropping them resulted in more than 10% change in the odds

ratio. Prior to assessment for effect modification the model was checked for any problems collinearity and interaction terms with maternal age, asset index and sex had to be dropped.

Multivariate models were also built for the associations: Malaria and elevated CRP, diarrhea and elevated CRP or AGP, fever and elevated CRP, fever and elevated AGP, and fever and elevated CRP or AGP. Covariates assessed with each model: socioeconomic status, gender, child age, maternal age, child stunting, child wasting and current breastfeeding status. Both the associations of malaria and elevated CRP and and diarrhea and either elevated CRP or AGP had no significant confounding and interaction. With fever and elevated CRP, categorical child age was found to be a significant effect modifier and the association was confounded by breastfeeding status; stunting was found to be independently significant and retained for final model. The association of fever and either elevated CRP or AGP had effect modification by breastfeeding status.

Results

Demographics

Of the 849 preschool aged children included in the survey, the mean age was 21.4 months (median 23 months) and 50.2% were male (Table 1). The mean age for mothers was 26.9 year (median 25 years). About half, 54.3 %, of the children were currently breastfeeding and 91.4% having ever breastfed. Most of the households were without electricity (98.2%) and made with mud or dung walls (95.2%). About a third (31.3%) had grass or reed roofs. Insecticide treated bed nets were observed in use in vast majority of the households, 92.7%.

Health Characteristics

Median CRP level was 2.0 mg/L and 34.2% (Table 1) of the population had elevated CRP levels (>5.0 mg/L). Median AGP level was 1.1 g/L and 60.8% had elevated AGP levels (>1.0 g/L). 33.0% had both elevated CRP and AGP levels and 62.0% had at least one elevated marker of inflammation. 32.4% of the children had non-malarial inflammation.

Levels of anemia (71.7%) and severe anemia (8.1%) were high and 31.0% had low Vitamin A levels (RBP < 0.7 µg/L). About a third (33.1%) of the population was positive for malaria and 41.6% reported fever in the last 24 hours. 24.4% reported diarrhea in the previous 24 hours. 26.1% had stunted growth and 3.3% were wasted.

Bivariate Models

All fifteen bivariate models for inflammation biomarkers and acute illness outcomes showed significant associations (Table 3). The association between inflammation and malaria appeared to be the strongest with all three inflammation indicators (elevated CRP, elevated AGP, either elevated CRP or AGP). The odds of a positive blood smear for malaria was 7.7 ($p < .001$) for children with elevated CRP compared to those with normal levels. For those with elevated AGP the odds of malaria were 7.7 (<.001) compared to normal AGP levels. For those with either elevated CRP or AGP the odds of malaria was 8.1 ($p < .001$) compared to those with normal levels of both CRP and AGP.

The odds of fever within in the last 24 hours was 3.7 ($p < .001$) comparing those with elevated CRP to those with normal levels. The odds were 2.6 ($p < .001$) for those with elevated AGP in comparison to those with normal AGP levels. When any inflammation is considered the odds of fever increase to 2.6 ($p < .001$) contrasted to those with normal CRP and AGP levels.

While still significant, the association with reported diarrhea in the last 24 hours was not as strong. The odds of diarrhea were 1.4 ($p = .0414$) for those with elevated CRP compared to those with normal levels. The odds are slightly higher, 1.6 ($p = .0029$) for those with elevated AGP compared to those with normal AGP levels. Among those with any inflammation the odds are 1.7 ($p = .0014$) for diarrhea compared to those with non-elevated CRP and AGP levels.

As expected CRP and AGP are strongly associated with each other; the odds of having elevated AGP is 38.3 ($p < .0001$) for those with elevated CRP compared to those with normal CRP levels. CRP and AGP levels are also linearly related, $t=21.14$ ($p < .001$).

Multivariate Models

Malaria

A multivariate model was built using positive malaria blood smear as the outceom and either elevated CRP or AGP as primary exposure. Interaction of inflammation and asset index, sex, age, maternal age, wasting status, stunting status and current breastfeeding was evaluated using log likelihood ratio test and backwards elimination, none were found to be significant. Confounding by these factors was also assed using all possible subsets and none were found to be significant using the 10% change in the odds ratio as the cut-off. None of the covariates were found to be significant, using 10%, when assed alone with inflammation in the model as well. A multivariate model was also created to assess the association between elevated CRP and malaria, once again none of the covariates were found to be significant for interaction or confounding.

Diarrhea

The strongest observed association for the outcome of diarrhea was with any inflammation; when the other potential covariates were assessed for interaction or confounding none were found to be significant.

Fever

The relationship between fever and elevated CRP were found to have significant effect modification by child's age and had to be adjusted for breastfeeding status. Stunting was also found to be independently associated (p=.0271) and thus was retained in final model (Table 4). The strongest association was observed with the middle age category, 12 ≤ and < 24 months (POR 4.6; 2.8, 7.7). Among children aged 6 to 12 months, the POR was slightly lower at 3.7 (1.6, 8.9) adjusting for breastfeeding status. The eldest age category, 24 to 35 months, had the lowest prevalence odds ratio (2.5; 1.5, 4.3). The association between fever and either elevated CRP or AGP had effect modification by breastfeeding, although no other variables were found to be significant confounders. Among children currently breastfeeding the POR was 3.3 (2.2, 5.0). The association was also significant among children not currently breastfeeding (2.0; 1.3, 3.0).

Discussion

Our study found statistically significant associations of all reported acute disease outcomes (malaria, fever, diarrhea, and any of the three) and all three inflammation markers (elevated CRP, elevated AGP, and either elevated CRP or AGP). Median C-reactive protein (CRP) level of the population was 2.0 mg/L and the mean level was 9.1 mg/L, well above the cut-off of 5.0 mg/L used in our study to indicate presence of inflammation. The observed median is higher than the average levels of healthy young adults in the United States (8). While the median value is below the typical cut-off for chronic inflammation, 3.0 mg/L, it is higher than what would be expected in a healthy population which is indicative of the high levels of acute illness present (9). Both the observed median level, 1.1 mg/L, and mean level,1.2 mg/L, of α-1-acid-glycoprotein (AGP) are above the cut-off for inflammation of 1.0 mg/L (2). This is not surprising since 60.8% of the study population had elevated levels of AGP.

Fever was the most common acute illness reported with 41.6% of population reporting the presence of fever in the last 24 hours; 33.1% of the population was positive for malaria and 24.4% reported diarrhea in the last 24 hours. Over half, 54.9%, of the population reported the presence at least one acute illness outcome within the 24 hours preceding the survey. Fever is a common symptom of malaria, and 18.8% of the population, or 44.8% of those with fever, had both fever and a positive malaria blood smear. All three outcomes were reported in 5.9% of the population, while 34.5 % reported none of the three (Table 2). The presence of multiple acute outcomes was common as only 15.6% reported fever alone, 12.2% malaria alone and 8.7% diarrhea alone. Malaria was the only outcome where a clinical diagnosis was used, based on

positive blood smears, all other outcomes were categorized based on self-reporting by the child's caregiver who completed the questionnaire.

The Nyando Integrated Child Health and Education (NICHE) baseline study was conducted in March and April of 2007 and found 19.8% of children aged 6-35 months had a positive blood smear for malaria, 21.5% had experienced an acute respiratory infection in the last 24 hours, and 9.1% had diarrhea (47). Our survey, conducted three years later, showed a higher prevalence of both malaria and diarrhea but only included a subset of the households included in the baseline, so direct comparisons between the two surveys cannot be made. The World Health Organization defines persistent anemia in a population as 40%, we observed 71.7% of the study population to be anemic and 8.1% to be severely anemic indicating a severe public health problem with anemia. This coupled with the high prevalence of acute illness, 54.9% reported at least one acute illness, indicates the poor state of health of preschool aged children in the region. The high malaria burden may especially be contributing significantly to the observed levels of anemia. Previous research on this same data suggests that inflammation may be an intermediate on the causal pathway from malaria to anemia (37).

The unadjusted associations from the bivariate models of acute illness outcomes and elevated markers of inflammation were all significant (Table 3). Malaria had the strongest association with all three exposures (elevated CRP, elevated AGP, elevated CRP or AGP). Overall the strongest unadjusted association we observed was the prevalence odd ratio for malaria and elevated CRP or AGP of 8.1 (95% Confidence Interval 5.2, 12.4, $p < .001$). The association between malaria and elevated CRP has been observed in other populations as well so this result was expected (13, 19, 31, 50).

However, it was surprising that no significant confounders of the associations were found, since factors including malnutrition, age, and sex are all known contributors to the variation observed in inflammation levels (3, 4, 42). While other studies have found these covariates to be associated with inflammation, the association between malaria and inflammation may be strong enough that the confounding present is negligible (14, 40, 42). Many of those studies also used lower cut-points to indicate elevated CRP levels since they primarily concerned with chronic inflammation.

The lack of confounding by age could also be due to the narrow age range of the study participants, 6-35 months, eliminating the need to further account for age. Additionally, many of the differences in inflammation associated with sex do not occur until after puberty (42). The population was fairly homogenous in regards to socioeconomic status as well, 86.1% of the original NICHE population fell within the poorest Kenya socioeconomic quintile (47). The homogenous nature of the population may mean that some of the confounding was addressed by the study design. Furthermore, much of the research regarding factors such as chronic stress or socioeconomic status with inflammation was conducted in the United States or other high resource setting and thus may not applicable to our study population (14, 40, 42). Anemia could not be included as a covariate because inflammation is believed to be an intermediate in the causal pathway for malaria and anemia, and may also be for other acute illnesses.

Child's age was found to be a significant effect modifier on the association between fever and elevated CRP levels. To address the effect modification the population was stratified into three age categories: $6 \geq$ and < 12 months, $12 \geq$ and < 24,

24 ≥ and ≤ 36 months (Table 4). Using the oldest category as a reference we found the middle age category to have the highest odds of fever (4.6; 2.8, 7.7) when adjusted for breastfeeding status and stunting (Table 4). This is not surprising as children this young are often at higher risk for many acute illness due to lack of acquired immunity and become more exposed to food and waterborne pathogens as they are weaned from exclusive breastfeeding.

The association of fever and any inflammation had significant effect modification by breastfeeding status, but no other variables were found to be significant confounders. Amongst children who are currently being breastfeed the prevalence odds ratio was 3.3 (2.2, 5.0). The prevalence odds of fever were 2.0 (1.3, 3.0) times higher for those with inflammation compared to those without for children who are not currently breastfeeding. The effect modification may not be a result of the actual breastfeeding but could also be a proxy for age since younger tend to be the ones still breastfeeding. As noted previously age was an effect modifier for the association between fever and elevated CRP.

While a majority, 60.8%, of the population had elevated AGP levels only 34.2% of the population was observed to have elevated CRP. About a third, 33.0%, had elevated levels of both biomarkers. Accordingly, we observed more children with elevated AGP levels than CRP levels as elevated AGP alone was observed in 27.8% of the population and elevated CRP alone was only observed in 1.8%. This may be because CRP levels rapidly rise after stimulus of the acute phase response, reaching their maximum levels at about 48 hours, and CRP has a short half-life so levels rapidly decrease, creating a short window where elevated CRP is observed alone (8). Levels of AGP are known to stay elevated for up to three weeks after parasitemia is cleared

following the resolution of malaria and so in region with endemic malaria we would expect to see a high prevalence of elevated AGP (19).

Severe malnutrition has been shown to diminish the acute phase response in children but this was not observed in our population (1, 34). About a fourth, 26.1 %, of the study population are considered to be stunted and 3.3 % are concerned wasted. While both stunting and wasting were assessed for confounding and effect modification, neither was found to be statistically significant. A bivariate analysis did find both to be statistically associated with inflammation. The unadjusted odds of wasting were 5.4 (p=.005) times greater for those with elevated CRP or AGP compared to those with any inflammation. The unadjusted odds of stunting were 1.5 times greater for those with elevated CRP or AGP compared to those with normal levels. Stunting was also found to be independently significant and included in the model for fever and elevated CRP. Wasting was the only covariate to be significantly associated with all three exposures (Table 5). Wasting may also be a result of the acute illness outcome, which can cause rapid short term weight loss. However, wasting did prove to be a significant confounder when assed with both the exposure and outcome.

Limitations

One of the major limitations of the study is that the prevalence odds ratios calculated through logistic regression overestimate the prevalence ratios. The prevalence odds ratio of malaria and elevated CRP was 7.7 while the prevalence ratio was only 3.4. Furthermore, the prevalence odds ratio for malaria and elevated AGP was 1.9 while the POR was 7.7. So while the PORs show that the association between malaria and elevated

CRP and AGP are the same, their prevalence ratios suggest this is not true. The overestimation may occur partially due to high prevalence of the reported acute illness. This is especially true with malaria, where 47.1% of those with normal AGP levels were still positive for malaria.

The survey used did not collect information on the HIV status of participants which is a limitation of the study. HIV/AIDS is known to affect inflammation levels and make an individual more susceptible to acute illness and infections (34, 51). In addition, information was also not collected on intestinal parasites or other helminthes such as schistosomasis and the observed inflammation may be at least partially due to infection with multiple parasites (52). Although there is some debate on the extent to which helminthes elicit an inflammatory response, without further information we cannot address this issue (53). The study would be further enhanced by the inclusion of data on other tropical entreopathy as well which could also be influencing the rate of inflammation in the region.

Except for malaria, all of our outcomes were self-reported which may not be the most accurate and could have led to misclassification. Since malaria is our only clinically confirmed condition, this may be contributing to its strong association with inflammation in comparison of the other outcomes. Both fever and diarrhea can be symptoms of malaria as well and further insight would be gained by examining their association with CRP and AGP without the presence of malaria.

The study was carried out in Nyando District, Kenya and likely not representative of the rest of Kenya or Sub-Saharan Africa at large. It was a cross-sectional study and

thus we cannot determine causality, only associations and can only calculate odd ratios. The cluster design of the study also resulted in large confidence intervals. Since 61.96% of the study population had elevated CRP or AGP, there was a smaller unexposed group and that may have influenced the results.

The study would benefit from further analysis of the relationship between malaria parasite levels and biomarker levels. There is documentation that the severity and malaria parasite load are associated with CRP levels but similar information about AGP and parasite load is unavailable (1, 19, 50). Our study also did not explore the association between inflammation and the severity of disease, which has also been previously documented (12, 19, 28). Literature addressing the association between AGP and parasite density is especially lacking. Also of interest would be to see how the associations change if the cut-offs for inflammation are adjusted, particularly if the CRP cut-off is increased to 10 mg/L. It may also be beneficial to examine the association with fever and/or diarrhea and non-malarial inflammation. While the association would likely remain, it may not be as strong or influenced by other covariates.

Conclusions

Reported acute illnesses, especially malaria, have a strong association with both CRP and AGP but, the biomarkers cannot likely be used to distinguish between illnesses. CRP has a very low specificity when used to diagnosis malaria alone due to the non-specific response of the acute phase response to infection (3, 50). The use of inflammation biomarkers instead of self-reported acute illness outcomes may be

beneficial to improve accuracy and because they become elevated even in the presence of subclinical illness (3).

The data used in this study comes from a cross-sectional survey originally designed to provide information on nutritional status and anemia within the population. Typically as part of nutritional studies information on current health status, the disease outcomes, and biomarkers of inflammation, which need to be controlled, are collected. But, our analysis shows a strong association between the biomarkers, CRP and AGP, and reported acute illness (malaria, diarrhea, and fever) and was not confounded by typical features such as sex or nutritional status. Overall, malaria had the strongest associations with CRP and AGP. This indicates that elevated CRP or AGP may have the potential to be used to estimate the burden of acute illness in the population. This may allow us to gather more accurate prevalence information then what is determined through self-reporting.

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Tables

Table 1

Demographic and anthropometric characteristics of study population, preschool aged children (6-35 months) in Nyando District Kenya, August 2010[*†]

	N	% or median (95% CI or interquartile range)[\\]
Prevalence of Acute Illness		
Malaria (%)	828	33.1 (29.1, 37.3)
Fever in the last 24 hours (%)	825	41.6 (38.0, 45.3)
Diarrhea in the last 24 hours (%)	829	24.4 (20.8, 29.4)
Any acute illness (%)	849	54.9 (51.0, 58.7)
Inflammation Biomarkers		
CRP (mg/L) (interquartile range)	849	2.00 (0.4, 15.6)
Elevated CRP (CRP > 5 mg/L) (%)	849	34.2 (29.8, 38.8)
AGP (g/L) (interquartile range)	849	1.1 (0.8, 1.4)
Elevated AGP (AGP > 1 g/L) (%)	849	60.8 (56.0, 65.3)
Elevated CRP & AGP (%)	849	33.0 (28.7, 37.6)
Any Inflammation[‡] (%)	849	62.0 (57.2, 66.5)
Non-malarial inflammation[§] (%)	828	32.4 (28.1, 37.0)
Children		
Male (%)	849	50.2 (46.8, 53.2)
Age in months (interquartile range)	849	23.0 (14.0, 28.0)
Ever breastfed (%)	849	91.4 (88.0, 93.9)
Currently breastfeeding (%)	763	54.3 (50.3, 58.3)
Stunted (HAZ < 2) (%)	844	26.1 (23.1, 29.3)
Wasted (WHZ < 2) (%)	843	3.3 (2.1, 5.2)
Body Mass Index (interquartile range)	846	16.2 (15.3, 17.2)
Observed insecticide-treated net in use (%)	827	92.7 (90.3, 94.6)
Hemoglobin (g/dL) (interquartile range)	847	98.0 (83.0, 111.0)
Anemia (Hb < 11.0 g/dL) (%)	847	71.7 (68.0, 75.1)
Severe Anemia (Hb < 7.0 g/dL) (%)	847	8.1 (6.7, 10.7)
Low ferritin (< 12 µg/L) (%)	849	19.1 (16.0, 22.7)
Low RBP (RBP < 0.7µg/L) (%)	849	31.0 (27.2, 35.0)
Mothers		
Age in years (interquartile range)	823	25.0 (21.0, 30.0)
Household		
SES quintiles[¶]	834	
1 (poorest) (%)		16.7 (13.0, 21.0)
2		23.3 (20.2, 26.6)
3		26.1 (22.5, 30.2)
4		16.6 (13.7, 19.8)
5 (wealthiest)		17.4 (14.1, 21.2)
No electricity (%)	827	98.2 (96.5, 99.1)
Grass/Reed roof (%)	828	31.3 (26.3, 36.8)
Dung or mud walls (%)	828	95.2 (92.3, 97.0)
Treat water	838	91.9 (89.4, 93.8)

*Values are percent or median with 95% confidence intervals (CI) or interquartile range in parenthesis.

†Abbreviations: CRP C - reactive protein; AGP alpha-1-acid-glycoprotein; HAZ height-for-age Z-score; WHZ weight-for-age Z-score; RBP retinol binding protein; SES socioeconomic status.

‡Any inflammation was defined as any child with CRP>5 mg/L or AGP > 1g/L.

§Non-malarial inflammation was defined as CRP>5 mg/L or AGP > 1g/L in children without malaria.

¶Quintiles of relative SES were based on household assets using a principal component analysis

\\ CI account for cluster survey design

Table 2

Acute illness outcomes in preschool aged children (9-35 months) in Nyando District Kenya, August 2010

Malaria	Fever	Diarrhea	% (95% Confidence Intervals*)
Y	N	N	12.2 (9.5, 14.9)†
N	Y	N	15.6 (13.3, 17.9)
N	N	Y	8.7 (6.7, 10.6)
Y	Y	Y	5.9 (3.7, 8.2)
Y	Y	N	13.1 (10.8, 15.3)
Y	N	Y	2.4 (1.4, 3.4)
N	N	N	7.7 (5.8, 9.6)
N	N	N	34.5 (30.8, 38.1)

*CI account for cluster survey design

† N=795; only includes children with values collected for all three acute illness outcomes

Table 3

Bivariate logistic regression models for elevated CRP or AGP with acute disease outcomes in preschool aged children (9-35 months) in Nyando District Kenya, August 2010

		N	Elevated CRP (%)	POR	95% CI[†]	P-Value
Malaria	Yes	274	64.6	7.7	5.2, 11.4	<.001
	No	554	19.1			
		828				
Fever	Yes	343	51.6	3.7	2.7, 5.1	<.001
	No	475	22.3			
		818				
Diarrhea	Yes	202	40.6	1.4	1.0, 2.0	.0414
	No	623	32.6			
		825				
Any[*]	Yes	466	50.9	6.4	4.4, 9.4	<.001
	No	383	13.8			
		849				
			Elevated AGP (%)			
Malaria	Yes	274	87.2	7.7	5.1, 11.52	<.001
	No	554	47.1			
		828				
Fever	Yes	343	73.8	2.6	1.9, 3.6	<.001
	No	475	51.8			
		818				
Diarrhea	Yes	202	69.3	1.6	1.2, 2.2	.0029
	No	623	58.1			
		825				
Any[*]	Yes	466	75.8	4.2	3.1, 5.7	<.001
	No	383	42.6			
		849				
			Elevated CRP or AGP (%)			
Malaria	Yes	274	88.3	8.1	5.2, 12.4	<.001
	No	554	48.4			
		828				
Fever	Yes	343	74.9	2.6	1.9, 3.6	<.001
	No	475	53.1			
		818				
Diarrhea	Yes	202	71.3	1.7	1.2,2.4	.0007
	No	623	59.0			
		825				
Any[*]	Yes	466	76.8	4.2	3.1, 5.8	<.001
	No	383	43.9			
		849				

*Any defined as at least one positive response for malaria, fever, or diarrhea.

† CI account for cluster survey design

Table 4

Multivariate logistic regression models for elevated CRP and elevated CRP or AGP with fever in preschool aged children (9-35 months) in Nyando District Kenya, August 2010

	Fever	*N*	Elevated CRP (%)	POR	95% CI‡	P-Value
6-12 Months*	Yes	64	45.3	3.7	1.6, 8.9	.0031
	No	64	23.4			
		128				
12-24 Months*	Yes	128	61.7	4.6	2.8, 7.7	<.0001
	No	190	16.8			
		318				
24-36 Months*	Yes	151	45.7	2.5	1.5, 4.3	.0005
	No	221	26.7			
		372				
			Elevated CRP or AGP (%)			
Breastfeeding †	Yes	186	77.9	3.3	2.2, 5.0	<.0001
	No	220	47.7			
Not Breastfeeding†	Yes	136	71.3	2.0	1.3, 3.0	.0011
	No	207	55.6			

*Model included categorical age variable, categorical variable for breastfeeding, categorical variable for stunting and interaction term for exposure with categorical age; N=746

† Model included categorical breastfeeding variable and interaction term for exposure with categorical breastfeeding; N=748

‡CI account for cluster survey design

Table 5

Bivariate logistic regression models for elevated CRP or AGP with potential covariates

	N	POR	95% CI*	P-Value
CRP				
Asset Index	834	1.3	0.7, 2.3	.3711
Sex	849	1.2	0.9, 1.7	.1321
Child Age (<6 vs. ≥ 24)	849	1.0	0.7, 1.6	.9120
Maternal Age	823	1.0	0.9, 1.0	.1380
Wasting	843	2.7	1.0, 7.2	.0496
Stunting	844	1.1	0.8, 1.5	.6015
Currently Breastfeeding	762	1.1	0.9, 1.5	.3669
AGP				
Asset Index	834	2.2	1.3, 3.9	.0053
Sex	849	1.2	0.9, 1.5	.2554
Child Age (<6 vs. ≥ 24)	849	1.0	0.7, 1.4	.8910
Maternal Age	823	1.0	0.9, 1.0	.0723
Wasting	843	5.7	1.7, 18.6	.0041
Stunting	844	1.5	1.1, 2.0	.0079
Currently Breastfeeding	762	0.9	0.7, 1.3	.7348
CRP or AGP				
Asset Index	834	2.2	1.3, 4.0	.0042
Sex	849	1.2	1.0, 1.6	.1075
Child Age (<6 vs. ≥24)	849	1.0	0.7, 1.5	.9693
Maternal Age	823	1.0	0.9, 1.0	.0951
Wasting	843	5.4	1.7, 17.5	.0052
Stunting	844	1.5	1.1, 2.1	.0052
Currently Breastfeeding	762	1.0	0.7, 1.4	.9126

*CI account for cluster survey design

Chapter III: Public Health Implications and Future Directions

While CRP and AGP have a strong association with acute illness, especially malaria, they cannot likely be used to distinguish between illnesses. High CRP levels have been shown to be indicative of recent clinical malaria episodes in currently afebrile individuals with high parasite densities but among febrile patients this association does not hold up (50). CRP has a very low specificity when used to diagnosis malaria alone due to the non-specific response of the acute phase response to infection (3, 50). The use of inflammation biomarkers instead of self-reported acute illness outcomes may be beneficial to improve accuracy and because they become elevated even in the presence of subclinical illness (3).

The data used in this study comes from a cross-sectional survey originally designed to provide information on nutritional status and anemia within the population. Typically as part of nutritional studies information on current health status, the disease outcomes, and biomarkers of inflammation, which need to be controlled, are collected. But, our analysis shows a strong association between the biomarkers, CRP and AGP, and acute illness (malaria, diarrhea, and fever) and was not confounded by typical features such as sex or nutritional status. These significant associations support the use of inflammation biomarkers to assess the prevalence of acute illness.

While this study provided further insight into the association between inflammation biomarkers and acute illness further research is still needed. Some studies have observed associations of CRP levels with malaria parasitism, but there are mixed results especially in regards to CRP levels and severity of disease neither of which were not addressed in our study (31, 33). The relationship between AGP and malaria is even less understood, and our research indicates that a strong association exists as well. More research is needed to determine if AGP levels have a similar association with parasitism or severity as has been observed with CRP.

Our study was cross-sectional and a larger longitudinal survey could provide more insight and could potentially show when the biomarkers can, or cannot, be detected over the course of an illness. With fever we saw interaction by age, even with our narrow age range of 6-35 months. Widening the age range may illuminate how the acute phase response varies across ages. This interaction may also be due in part to acquired immunity gained as the children age and a larger study may help address this. In our study the only outcome for which we observed effect modification by age was fever and a larger study could show if this is unique to fever, or similar effect modification occurs with other acute illnesses.

We found 62% of the study population to have elevated levels of either CRP or AGP; indicating a heavy burden of acute illness in the region. Due to strong association between these biomarkers and acute illness, CPR and AGP levels may have the potential to serve as indicators of a community's acute disease burden. In instances, such as our study, where self-reporting is used they may prove to be even more effective since they can indicate subclinical infection. The associations will need to be examined in depth

and cut-offs should be determined to maximize both the sensitivity and specificity before this can occur. One of the major limitations of this study is that it is cross-sectional; a longitudinal cohort study would allow us to determine causality or better determine when biomarker levels begin to increase over the course of an illness. Establishing baseline levels, or levels in healthy individuals, would allow to better determine what cut-offs should be used to indicate inflammation in areas of high acute illness prevalence.

While more information is needed to fully understand the association of CRP and AGP and acute illness, we can conclude that a strong association does exist. This association has the potential to provide accurate assessment of acute illness prevalence when clinical diagnosis is not available, especially in regards to malaria.

Appendix

Appendix A: SAS Code

Exposure: Any Inflammation Outcome: Malaria

```
Proc surveylogistic data=three;
   Cluster cluster;
   Class asset (REF='4') /param=ref;
   Class age2 (REF='3') /param=ref;
   Model malaria1 (Event='1') = inflam asset sex age2 mat_yr wfh hfa
brfeed inflam*age2 inflam*wfh inflam*hfa inflam*brfeed;
run;
```

Model Fit Statistics

Criterion	Intercept Only	Intercept and Covariates
AIC	916.754	816.391
SC	921.338	898.893
-2 Log L	914.754	780.391

Testing Global Null Hypothesis: BETA=0

Test	Chi-Square	DF	Pr > ChiSq
Likelihood Ratio	134.3632	17	<.0001
Score	118.3756	17	<.0001
Wald	423.1003	17	<.0001

Type 3 Analysis of Effects

Effect	DF	Wald Chi-Square	Pr > ChiSq
Inflame	1	32.1060	<.0001
Asset	4	0.4307	0.9799
SEX	1	0.0380	0.8454
age2	2	3.8871	0.1432
mat_yr	1	2.2591	0.1328
WFH	1	168.4709	<.0001
HFA	1	0.0020	0.9645
Brfeed	1	4.2107	0.0402

Type 3 Analysis of Effects

Effect	DF	Wald Chi-Square	Pr > ChiSq
inflam*age2	2	1.7215	0.4228
inflam*WFH	1	151.8715	<.0001
inflam*HFA	1	0.0191	0.8900
inflam*brfeed	1	4.8176	0.0282

Analysis of Maximum Likelihood Estimates

Parameter		DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept		1	-1.7384	0.5011	12.0351	0.0005
inflam		1	2.2718	0.4009	32.1060	<.0001
asset	**0**	1	0.1245	0.3284	0.1438	0.7046
asset	**1**	1	-0.0665	0.3124	0.0453	0.8315
asset	**2**	1	0.0293	0.3124	0.0088	0.9252
asset	**3**	1	0.0800	0.3145	0.0647	0.7991
SEX		1	-0.0360	0.1846	0.0380	0.8454
age2	**1**	1	-1.7405	1.1167	2.4292	0.1191
age2	**2**	1	-0.7631	0.4907	2.4178	0.1200
mat_yr		1	-0.0152	0.0101	2.2591	0.1328
WFH		1	-11.1755	0.8610	168.4709	<.0001
HFA		1	-0.0193	0.4329	0.0020	0.9645
brfeed		1	0.9179	0.4473	4.2107	0.0402
inflam*age2	**1**	1	1.3727	1.2441	1.2175	0.2698
inflam*age2	**2**	1	0.6504	0.5938	1.1999	0.2733
inflam*WFH		1	10.8643	0.8816	151.8715	<.0001
inflam*HFA		1	0.0640	0.4628	0.0191	0.8900
inflam*brfeed		1	-1.0996	0.5010	4.8176	0.0282

```
*Drop inflam*hfa, p-value= .8900;
Proc surveylogistic data=three;
   Cluster cluster;
   Class asset (REF='4') /param=ref;
   Class age2 (REF='3') /param=ref;
   Model malaria1 (Event='1') = inflam asset sex age2 mat_yr wfh hfa
brfeed inflam*age2 inflam*wfh inflam*brfeed;
run;
```

Model Fit Statistics		
Criterion	**Intercept Only**	**Intercept and Covariates**
AIC	916.754	814.406
SC	921.338	892.324
-2 Log L	914.754	780.406

Testing Global Null Hypothesis: BETA=0			
Test	**Chi-Square**	**DF**	**Pr > ChiSq**
Likelihood Ratio	134.3481	16	<.0001
Score	118.3523	16	<.0001
Wald	417.8864	16	<.0001

Type 3 Analysis of Effects			
Effect	**DF**	**Wald Chi-Square**	**Pr > ChiSq**
inflam	1	40.0603	<.0001
asset	4	0.4315	0.9798
SEX	1	0.0366	0.8484
age2	2	3.8480	0.1460
mat_yr	1	2.1772	0.1401
WFH	1	175.0720	<.0001
HFA	1	0.0314	0.8594
brfeed	1	4.0921	0.0431
inflam*age2	2	1.7034	0.4267
inflam*WFH	1	153.3427	<.0001
inflam*brfeed	1	4.7609	0.0291

Analysis of Maximum Likelihood Estimates					
Parameter		**DF**	**Estimate**	**Standard Error**	**Wald Chi-Square**	**Pr > ChiSq**
Intercept		1	-1.7560	0.4824	13.2473	0.0003
inflam		1	2.2905	0.3619	40.0603	<.0001
asset	**0**	1	0.1251	0.3280	0.1454	0.7029
asset	**1**	1	-0.0666	0.3119	0.0456	0.8309

Analysis of Maximum Likelihood Estimates

Parameter		DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
asset	**2**	1	0.0282	0.3108	0.0082	0.9278
asset	**3**	1	0.0786	0.3167	0.0616	0.8040
SEX		1	-0.0353	0.1844	0.0366	0.8484
age2	**1**	1	-1.7277	1.1231	2.3664	0.1240
age2	**2**	1	-0.7584	0.4869	2.4257	0.1194
mat_yr		1	-0.0151	0.0102	2.1772	0.1401
WFH		1	-11.1953	0.8461	175.0720	<.0001
HFA		1	0.0328	0.1855	0.0314	0.8594
brfeed		1	0.9150	0.4523	4.0921	0.0431
inflam*age2	**1**	1	1.3572	1.2493	1.1803	0.2773
inflam*age2	**2**	1	0.6441	0.5873	1.2028	0.2728
inflam*WFH		1	10.8855	0.8791	153.3427	<.0001
inflam*brfeed		1	-1.0977	0.5031	4.7609	0.0291

```
*Drop inflam*hfa, p-value= .8900;
Proc surveylogistic data=three;
   Cluster cluster;
   Class asset (REF='4') /param=ref;
   Class age2 (REF='3') /param=ref;
   Model malaria1 (Event='1') = inflam asset sex age2 mat_yr wfh hfa
brfeed inflam*age2 inflam*wfh inflam*brfeed;
run;
```

Model Fit Statistics

Criterion	Intercept Only	Intercept and Covariates
AIC	916.754	814.406
SC	921.338	892.324
-2 Log L	914.754	780.406

Testing Global Null Hypothesis: BETA=0

Test	Chi-Square	DF	Pr > ChiSq
Likelihood Ratio	134.3481	16	<.0001
Score	118.3523	16	<.0001

Testing Global Null Hypothesis: BETA=0			
Test	**Chi-Square**	**DF**	**Pr > ChiSq**
Wald	417.8864	16	<.0001

Type 3 Analysis of Effects			
Effect	**DF**	**Wald Chi-Square**	**Pr > ChiSq**
inflam	1	40.0603	<.0001
asset	4	0.4315	0.9798
SEX	1	0.0366	0.8484
age2	2	3.8480	0.1460
mat_yr	1	2.1772	0.1401
WFH	1	175.0720	<.0001
HFA	1	0.0314	0.8594
brfeed	1	4.0921	0.0431
inflam*age2	2	1.7034	0.4267
inflam*WFH	1	153.3427	<.0001
inflam*brfeed	1	4.7609	0.0291

Analysis of Maximum Likelihood Estimates						
Parameter		**DF**	**Estimate**	**Standard Error**	**Wald Chi-Square**	**Pr > ChiSq**
Intercept		1	-1.7560	0.4824	13.2473	0.0003
inflam		1	2.2905	0.3619	40.0603	<.0001
asset	**0**	1	0.1251	0.3280	0.1454	0.7029
asset	**1**	1	-0.0666	0.3119	0.0456	0.8309
asset	**2**	1	0.0282	0.3108	0.0082	0.9278
asset	**3**	1	0.0786	0.3167	0.0616	0.8040
SEX		1	-0.0353	0.1844	0.0366	0.8484
age2	**1**	1	-1.7277	1.1231	2.3664	0.1240
age2	**2**	1	-0.7584	0.4869	2.4257	0.1194
mat_yr		1	-0.0151	0.0102	2.1772	0.1401
WFH		1	-11.1953	0.8461	175.0720	<.0001
HFA		1	0.0328	0.1855	0.0314	0.8594
brfeed		1	0.9150	0.4523	4.0921	0.0431

Analysis of Maximum Likelihood Estimates						
Parameter		**DF**	**Estimate**	**Standard Error**	**Wald Chi-Square**	**Pr > ChiSq**
inflam*age2	**1**	1	1.3572	1.2493	1.1803	0.2773
inflam*age2	**2**	1	0.6441	0.5873	1.2028	0.2728
inflam*WFH		1	10.8855	0.8791	153.3427	<.0001
inflam*brfeed		1	-1.0977	0.5031	4.7609	0.0291

```
*Drop inflam*age2, p=.4267;
Proc surveylogistic data=three;
   Cluster cluster;
   Class asset (REF='4') /param=ref;
   Class age2 (REF='3') /param=ref;
   Model malaria1 (Event='1') = inflam asset sex age2 mat_yr wfh hfa
brfeed inflam*wfh inflam*brfeed;
run;
```

Model Fit Statistics		
Criterion	**Intercept Only**	**Intercept and Covariates**
AIC	916.754	813.247
SC	921.338	881.998
-2 Log L	914.754	783.247

Testing Global Null Hypothesis: BETA=0			
Test	**Chi-Square**	**DF**	**Pr > ChiSq**
Likelihood Ratio	131.5076	14	<.0001
Score	118.0657	14	<.0001
Wald	632.0123	14	<.0001

Type 3 Analysis of Effects			
Effect	**DF**	**Wald Chi-Square**	**Pr > ChiSq**
inflam	1	56.6212	<.0001
asset	4	0.4760	0.9758
SEX	1	0.0562	0.8126
age2	2	4.9997	0.0821
mat_yr	1	1.7133	0.1906
WFH	1	312.2908	<.0001

Type 3 Analysis of Effects

Effect	DF	Wald Chi-Square	Pr > ChiSq
HFA	1	0.0208	0.8852
brfeed	1	1.3551	0.2444
inflam*WFH	1	225.0544	<.0001
inflam*brfeed	1	1.7505	0.1858

Analysis of Maximum Likelihood Estimates

Parameter		DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept		1	-1.8880	0.4819	15.3475	<.0001
inflam		1	2.4314	0.3231	56.6212	<.0001
asset	**0**	1	0.1306	0.3276	0.1589	0.6902
asset	**1**	1	-0.0669	0.3117	0.0461	0.8300
asset	**2**	1	0.0339	0.3099	0.0119	0.9130
asset	**3**	1	0.0933	0.3146	0.0879	0.7669
SEX		1	-0.0438	0.1847	0.0562	0.8126
age2	**1**	1	-0.5953	0.2674	4.9550	0.0260
age2	**2**	1	-0.2420	0.2203	1.2070	0.2719
mat_yr		1	-0.0136	0.0104	1.7133	0.1906
WFH		1	-11.1724	0.6322	312.2908	<.0001
HFA		1	0.0267	0.1851	0.0208	0.8852
brfeed		1	0.5300	0.4553	1.3551	0.2444
inflam*WFH		1	10.8906	0.7260	225.0544	<.0001
inflam*brfeed		1	-0.6166	0.4661	1.7505	0.1858

```
*Drop inflam*brfeed, p=.1858;
Proc surveylogistic data=three;
   Cluster cluster;
   Class asset (REF='4') /param=ref;
   Class age2 (REF='3') /param=ref;
   Model malaria1 (Event='1') = inflam asset sex age2 mat_yr wfh hfa
brfeed inflam*wfh;
run;
```

Model Fit Statistics

Criterion	Intercept Only	Intercept and Covariates
AIC	916.754	813.165
SC	921.338	877.332
-2 Log L	914.754	785.165

Testing Global Null Hypothesis: BETA=0			
Test	**Chi-Square**	**DF**	**Pr > ChiSq**
Likelihood Ratio	129.5897	13	<.0001
Score	115.9496	13	<.0001
Wald	681.8695	13	<.0001

Type 3 Analysis of Effects			
Effect	**DF**	**Wald Chi-Square**	**Pr > ChiSq**
inflam	1	83.6892	<.0001
asset	4	0.4486	0.9783
SEX	1	0.0649	0.7989
age2	2	5.0649	0.0795
mat_yr	1	1.7848	0.1816
WFH	1	340.1663	<.0001
HFA	1	0.0541	0.8161
brfeed	1	0.0238	0.8773
inflam*WFH	1	226.7875	<.0001

Analysis of Maximum Likelihood Estimates						
Parameter		**DF**	**Estimate**	**Standard Error**	**Wald Chi-Square**	**Pr > ChiSq**
Intercept		1	-1.6150	0.4378	13.6108	0.0002
inflam		1	2.0879	0.2282	83.6892	<.0001
asset	**0**	1	0.1337	0.3300	0.1641	0.6854
asset	**1**	1	-0.0599	0.3132	0.0366	0.8483
asset	**2**	1	0.0449	0.3080	0.0212	0.8842
asset	**3**	1	0.0940	0.3127	0.0904	0.7637
SEX		1	-0.0468	0.1837	0.0649	0.7989

Analysis of Maximum Likelihood Estimates						
Parameter		**DF**	**Estimate**	**Standard Error**	**Wald Chi-Square**	**Pr > ChiSq**
age2	**1**	1	-0.6017	0.2691	4.9993	0.0254
age2	**2**	1	-0.2308	0.2206	1.0939	0.2956
mat_yr		1	-0.0137	0.0102	1.7848	0.1816
WFH		1	-11.0964	0.6016	340.1663	<.0001
HFA		1	0.0427	0.1838	0.0541	0.8161
brfeed		1	0.0337	0.2183	0.0238	0.8773
inflam*WFH		1	10.7870	0.7163	226.7875	<.0001

```
Full model with no interaction terms;
Proc surveylogistic data=three;
   Cluster cluster;
   Class asset (REF='4') /param=ref;
   Class age2 (REF='3') /param=ref;
   Model malaria1 (Event='1') = inflam asset sex age2 mat_yr wfh hfa
brfeed;
   Contrast "inflammation" inflam 1 /est=exp;
run;
```

Model Fit Statistics		
Criterion	**Intercept Only**	**Intercept and Covariates**
AIC	916.754	811.595
SC	921.338	871.179
-2 Log L	914.754	785.595

Testing Global Null Hypothesis: BETA=0			
Test	**Chi-Square**	**DF**	**Pr > ChiSq**
Likelihood Ratio	129.1599	12	<.0001
Score	115.9493	12	<.0001
Wald	110.1659	12	<.0001

Type 3 Analysis of Effects			
Effect	**DF**	**Wald Chi-Square**	**Pr > ChiSq**
inflam	1	83.9595	<.0001

Type 3 Analysis of Effects

Effect	DF	Wald Chi-Square	Pr > ChiSq
asset	4	0.4602	0.9773
SEX	1	0.0659	0.7974
age2	2	5.0537	0.0799
mat_yr	1	1.8047	0.1791
WFH	1	0.4164	0.5187
HFA	1	0.0522	0.8193
brfeed	1	0.0230	0.8796

Analysis of Maximum Likelihood Estimates

Parameter		DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept		1	-1.6192	0.4384	13.6382	0.0002
inflam		1	2.0977	0.2289	83.9595	<.0001
asset	**0**	1	0.1353	0.3304	0.1676	0.6822
asset	**1**	1	-0.0626	0.3129	0.0400	0.8414
asset	**2**	1	0.0437	0.3082	0.0201	0.8874
asset	**3**	1	0.0907	0.3129	0.0841	0.7718
SEX		1	-0.0470	0.1832	0.0659	0.7974
age2	**1**	1	-0.6009	0.2692	4.9840	0.0256
age2	**2**	1	-0.2288	0.2205	1.0769	0.2994
mat_yr		1	-0.0138	0.0102	1.8047	0.1791
WFH		1	-0.3501	0.5425	0.4164	0.5187
HFA		1	0.0419	0.1836	0.0522	0.8193
brfeed		1	0.0330	0.2179	0.0230	0.8796

Odds Ratio Estimates

Effect	Point Estimate	95% Wald Confidence Limits	
inflam	8.148	5.202	12.762
asset 0 vs 4	1.145	0.599	2.188
asset 1 vs 4	0.939	0.509	1.734
asset 2 vs 4	1.045	0.571	1.911

Odds Ratio Estimates			
Effect	**Point Estimate**	**95% Wald Confidence Limits**	
asset 3 vs 4	1.095	0.593	2.022
SEX	0.954	0.666	1.366
age2 1 vs 3	0.548	0.324	0.929
age2 2 vs 3	0.795	0.516	1.226
mat_yr	0.986	0.967	1.006
WFH	0.705	0.243	2.041
HFA	1.043	0.728	1.494
brfeed	1.034	0.674	1.584

Association of Predicted Probabilities and Observed Responses			
Percent Concordant	73.3	**Somers' D**	0.471
Percent Discordant	26.2	**Gamma**	0.474
Percent Tied	0.6	**Tau-a**	0.208
Pairs	115182	**c**	0.735

Contrast Test Results			
Contrast	**DF**	**Wald Chi-Square**	**Pr > ChiSq**
inflammation	1	83.9595	<.0001

Contrast Estimation and Testing Results by Row									
Contrast	**Type**	**Row**	**Estimate**	**Standard Error**	**Alpha**	**Confidence Limits**		**Wald Chi-Square**	**Pr > ChiSq**
inflammation	**EXP**	**1**	8.1478	1.8653	0.05	5.2020	12.7619	83.9595	<.0001

```
Model without any other covariates;
Proc surveylogistic data=three;
   Cluster cluster;
   Model malaria1 (Event='1') = inflam;
   Contrast 'inflammation' inflam 1 / est=exp;
run;
```

Model Fit Statistics

Criterion	Intercept Only	Intercept and Covariates
AIC	1053.273	917.314
SC	1057.992	926.752
-2 Log L	1051.273	913.314

Testing Global Null Hypothesis: BETA=0			
Test	**Chi-Square**	**DF**	**Pr > ChiSq**
Likelihood Ratio	137.9588	1	<.0001
Score	123.6613	1	<.0001
Wald	90.2422	1	<.0001

Analysis of Maximum Likelihood Estimates					
Parameter	**DF**	**Estimate**	**Standard Error**	**Wald Chi-Square**	**Pr > ChiSq**
Intercept	1	-2.1903	0.1989	121.2833	<.0001
inflam	1	2.0882	0.2198	90.2422	<.0001

Odds Ratio Estimates			
Effect	**Point Estimate**	**95% Wald Confidence Limits**	
inflam	8.070	5.245	12.417

Association of Predicted Probabilities and Observed Responses			
Percent Concordant	45.6	**Somers' D**	0.399
Percent Discordant	5.6	**Gamma**	0.780
Percent Tied	48.8	**Tau-a**	0.177
Pairs	151796	**c**	0.700

Contrast Test Results			
Contrast	**DF**	**Wald Chi-Square**	**Pr > ChiSq**
inflammation	1	90.2422	<.0001

Contrast Estimation and Testing Results by Row

Contrast	Type	Row	Estimate	Standard Error	Alpha	Confidence Limits		Wald Chi-Square	Pr > ChiSq
inflammation	**EXP**	**1**	8.0704	1.7740	0.05	5.2455	12.4167	90.2422	<.0001

Exposure: Elevated CRP Outcome: Malaria

```
*Full model with interaction terms;
Proc surveylogistic data=three;
   Cluster cluster;
   Class asset (REF='4') /param=ref;
   Class age2 (REF='3') /param=ref;
   Model malaria1 (Event='1') = e_crp asset sex age2 mat_yr wfh hfa
brfeed e_crp*asset e_crp*sex e_crp*age2 e_crp*mat_yr e_crp*wfh
e_crp*hfa e_crp*brfeed;
   Contrast 'CRP' e_crp 1 / est=exp;
run;
```

Model Fit Statistics		
Criterion	**Intercept Only**	**Intercept and Covariates**
AIC	916.754	784.831
SC	921.338	894.832
-2 Log L	914.754	736.831

Testing Global Null Hypothesis: BETA=0			
Test	**Chi-Square**	**DF**	**Pr > ChiSq**
Likelihood Ratio	177.9239	23	<.0001
Score	173.9227	23	<.0001
Wald	190.5892	23	<.0001

Type 3 Analysis of Effects			
Effect	**DF**	**Wald Chi-Square**	**Pr > ChiSq**
e_crp	1	7.5481	0.0060
asset	4	6.1950	0.1851
SEX	1	0.8698	0.3510
age2	2	6.9010	0.0317

Type 3 Analysis of Effects			
Effect	**DF**	**Wald Chi-Square**	**Pr > ChiSq**
mat_yr	1	6.1810	0.0129
WFH	1	0.3430	0.5581
HFA	1	0.2742	0.6005
brfeed	1	2.0557	0.1516
e_crp*asset	4	5.7026	0.2225
e_crp*SEX	1	3.1800	0.0745
e_crp*age2	2	2.3514	0.3086
e_crp*mat_yr	1	2.3535	0.1250
e_crp*WFH	1	1.6586	0.1978
e_crp*HFA	1	0.0153	0.9014
e_crp*brfeed	1	4.9696	0.0258

Analysis of Maximum Likelihood Estimates						
Parameter		**DF**	**Estimate**	**Standard Error**	**Wald Chi-Square**	**Pr > ChiSq**
Intercept		1	-1.0657	0.5892	3.2718	0.0705
e_crp		1	2.7226	0.9910	7.5481	0.0060
asset	**0**	1	0.5833	0.4785	1.4862	0.2228
asset	**1**	1	0.0730	0.4473	0.0267	0.8703
asset	**2**	1	0.4428	0.3770	1.3797	0.2401
asset	**3**	1	-0.1285	0.5655	0.0516	0.8202
SEX		1	0.2575	0.2761	0.8698	0.3510
age2	**1**	1	-0.9353	0.4589	4.1535	0.0415
age2	**2**	1	-0.6318	0.2920	4.6834	0.0305
mat_yr		1	-0.0389	0.0156	6.1810	0.0129
WFH		1	0.5217	0.8908	0.3430	0.5581
HFA		1	0.1483	0.2832	0.2742	0.6005
brfeed		1	0.4600	0.3208	2.0557	0.1516
e_crp*asset	**0**	1	-0.4546	0.6635	0.4694	0.4932
e_crp*asset	**1**	1	-0.1699	0.6286	0.0730	0.7869
e_crp*asset	**2**	1	-0.8736	0.4894	3.1858	0.0743
e_crp*asset	**3**	1	0.2548	0.7760	0.1078	0.7427

Analysis of Maximum Likelihood Estimates

Parameter		DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
e_crp*SEX		1	-0.7077	0.3968	3.1800	0.0745
e_crp*age2	1	1	0.7905	0.6838	1.3364	0.2477
e_crp*age2	2	1	0.7333	0.5022	2.1320	0.1443
e_crp*mat_yr		1	0.0389	0.0254	2.3535	0.1250
e_crp*WFH		1	-1.4328	1.1125	1.6586	0.1978
e_crp*HFA		1	-0.0492	0.3977	0.0153	0.9014
e_crp*brfeed		1	-1.0800	0.4844	4.9696	0.0258

Association of Predicted Probabilities and Observed Responses

Percent Concordant	78.6	**Somers' D**	0.577
Percent Discordant	20.9	**Gamma**	0.579
Percent Tied	0.5	**Tau-a**	0.254
Pairs	115182	**c**	0.788

Contrast Test Results

Contrast	DF	Wald Chi-Square	Pr > ChiSq
CRP	1	7.5481	0.0060

Contrast Estimation and Testing Results by Row

Contrast	Type	Row	Estimate	Standard Error	Alpha	Confidence Limits		Wald Chi-Square	Pr > ChiSq
CRP	**EXP**	**1**	15.2196	15.0823	0.05	2.1821	106.2	7.5481	0.0060

```
*Drop, e_crp*hfa, p=.9014;
Proc surveylogistic data=three;
   Cluster cluster;
   Class asset (REF='4') /param=ref;
   Class age2 (REF='3') /param=ref;
   Model malaria1 (Event='1') = e_crp asset sex age2 mat_yr wfh hfa
brfeed e_crp*asset e_crp*sex e_crp*age2 e_crp*mat_yr e_crp*wfh
e_crp*brfeed;
   Contrast 'CRP' e_crp 1 / est=exp;
run;
```

Model Fit Statistics

Criterion	Intercept Only	Intercept and Covariates
AIC	916.754	782.843
SC	921.338	888.261
-2 Log L	914.754	736.843

Testing Global Null Hypothesis: BETA=0			
Test	**Chi-Square**	**DF**	**Pr > ChiSq**
Likelihood Ratio	177.9117	22	<.0001
Score	173.9226	22	<.0001
Wald	174.8248	22	<.0001

Type 3 Analysis of Effects			
Effect	**DF**	**Wald Chi-Square**	**Pr > ChiSq**
e_crp	1	7.7676	0.0053
asset	4	6.2031	0.1845
SEX	1	0.8497	0.3566
age2	2	6.9565	0.0309
mat_yr	1	6.1823	0.0129
WFH	1	0.3461	0.5563
HFA	1	0.3327	0.5640
brfeed	1	2.0587	0.1513
e_crp*asset	4	5.7481	0.2188
e_crp*SEX	1	3.1177	0.0774
e_crp*age2	2	2.3886	0.3029
e_crp*mat_yr	1	2.3399	0.1261
e_crp*WFH	1	1.6546	0.1983
e_crp*brfeed	1	5.0204	0.0251

Analysis of Maximum Likelihood Estimates					
Parameter	**DF**	**Estimate**	**Standard Error**	**Wald Chi-Square**	**Pr > ChiSq**
Intercept	1	-1.0587	0.5837	3.2896	0.0697
e_crp	1	2.6989	0.9684	7.7676	0.0053

Analysis of Maximum Likelihood Estimates						
Parameter		**DF**	**Estimate**	**Standard Error**	**Wald Chi-Square**	**Pr > ChiSq**
asset	**0**	1	0.5854	0.4824	1.4728	0.2249
asset	**1**	1	0.0751	0.4498	0.0279	0.8674
asset	**2**	1	0.4446	0.3800	1.3689	0.2420
asset	**3**	1	-0.1267	0.5689	0.0496	0.8238
SEX		1	0.2554	0.2771	0.8497	0.3566
age2	**1**	1	-0.9394	0.4537	4.2870	0.0384
age2	**2**	1	-0.6328	0.2926	4.6773	0.0306
mat_yr		1	-0.0388	0.0156	6.1823	0.0129
WFH		1	0.5255	0.8932	0.3461	0.5563
HFA		1	0.1286	0.2229	0.3327	0.5640
brfeed		1	0.4599	0.3205	2.0587	0.1513
e_crp*asset	**0**	1	-0.4569	0.6654	0.4714	0.4923
e_crp*asset	**1**	1	-0.1765	0.6270	0.0792	0.7784
e_crp*asset	**2**	1	-0.8732	0.4894	3.1838	0.0744
e_crp*asset	**3**	1	0.2537	0.7772	0.1066	0.7441
e_crp*SEX		1	-0.7022	0.3977	3.1177	0.0774
e_crp*age2	**1**	1	0.8024	0.6672	1.4464	0.2291
e_crp*age2	**2**	1	0.7400	0.5082	2.1199	0.1454
e_crp*mat_yr		1	0.0388	0.0254	2.3399	0.1261
e_crp*WFH		1	-1.4416	1.1207	1.6546	0.1983
e_crp*brfeed		1	-1.0767	0.4805	5.0204	0.0251

```
*Drop e_crp*age2, p=.3029;
Proc surveylogistic data=three;
   Cluster cluster;
   Class asset (REF='4') /param=ref;
   Class age2 (REF='3') /param=ref;
   Model malaria1 (Event='1') = e_crp asset sex age2 mat_yr wfh hfa
brfeed e_crp*asset e_crp*sex e_crp*mat_yr e_crp*wfh e_crp*brfeed;
   Contrast 'CRP' e_crp 1 / est=exp;
run;
```

Model Fit Statistics

Criterion	Intercept Only	Intercept and Covariates
AIC	916.754	781.640
SC	921.338	877.891
-2 Log L	914.754	739.640

Testing Global Null Hypothesis: BETA=0			
Test	**Chi-Square**	**DF**	**Pr > ChiSq**
Likelihood Ratio	175.1147	20	<.0001
Score	172.5086	20	<.0001
Wald	179.2419	20	<.0001

Type 3 Analysis of Effects			
Effect	**DF**	**Wald Chi-Square**	**Pr > ChiSq**
e_crp	1	9.7756	0.0018
asset	4	7.2953	0.1211
SEX	1	0.7717	0.3797
age2	2	3.6712	0.1595
mat_yr	1	5.9172	0.0150
WFH	1	0.3339	0.5634
HFA	1	0.2330	0.6293
brfeed	1	0.7670	0.3812
e_crp*asset	4	6.2695	0.1799
e_crp*SEX	1	2.9418	0.0863
e_crp*mat_yr	1	2.0131	0.1559
e_crp*WFH	1	1.4627	0.2265
e_crp*brfeed	1	2.7651	0.0963

Analysis of Maximum Likelihood Estimates					
Parameter		**DF**	**Estimate**	**Standard Error**	**Wald Chi-Square**	**Pr > ChiSq**
Intercept		1	-1.1864	0.5788	4.2014	0.0404
e_crp		1	2.9552	0.9452	9.7756	0.0018
asset	**0**	1	0.5981	0.4743	1.5899	0.2073

Analysis of Maximum Likelihood Estimates

Parameter		DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
asset	**1**	1	0.0920	0.4428	0.0431	0.8355
asset	**2**	1	0.4775	0.3726	1.6418	0.2001
asset	**3**	1	-0.1395	0.5591	0.0622	0.8030
SEX		1	0.2421	0.2756	0.7717	0.3797
age2	**1**	1	-0.5595	0.3012	3.4509	0.0632
age2	**2**	1	-0.2952	0.2165	1.8585	0.1728
mat_yr		1	-0.0361	0.0148	5.9172	0.0150
WFH		1	0.5029	0.8704	0.3339	0.5634
HFA		1	0.1077	0.2231	0.2330	0.6293
brfeed		1	0.2538	0.2898	0.7670	0.3812
e_crp*asset	**0**	1	-0.4358	0.6574	0.4395	0.5074
e_crp*asset	**1**	1	-0.2097	0.6210	0.1140	0.7356
e_crp*asset	**2**	1	-0.8938	0.4809	3.4549	0.0631
e_crp*asset	**3**	1	0.3107	0.7629	0.1659	0.6838
e_crp*SEX		1	-0.6776	0.3950	2.9418	0.0863
e_crp*mat_yr		1	0.0351	0.0248	2.0131	0.1559
e_crp*WFH		1	-1.3520	1.1179	1.4627	0.2265
e_crp*brfeed		1	-0.6685	0.4020	2.7651	0.0963

```
*Drop e_crp*wfh, p=.2265;
Proc surveylogistic data=three;
   Cluster cluster;
   Class asset (REF='4') /param=ref;
   Class age2 (REF='3') /param=ref;
   Model malaria1 (Event='1') = e_crp asset sex age2 mat_yr wfh hfa
brfeed e_crp*asset e_crp*sex e_crp*mat_yr e_crp*brfeed;
   Contrast 'CRP' e_crp 1 / est=exp;
run;
```

Model Fit Statistics

Criterion	Intercept Only	Intercept and Covariates
AIC	916.754	781.669
SC	921.338	873.337

Model Fit Statistics		
Criterion	**Intercept Only**	**Intercept and Covariates**
-2 Log L	914.754	741.669

Testing Global Null Hypothesis: BETA=0			
Test	**Chi-Square**	**DF**	**Pr > ChiSq**
Likelihood Ratio	173.0855	19	<.0001
Score	170.1533	19	<.0001
Wald	181.6262	19	<.0001

Type 3 Analysis of Effects			
Effect	**DF**	**Wald Chi-Square**	**Pr > ChiSq**
e_crp	1	9.9395	0.0016
asset	4	7.4641	0.1133
SEX	1	0.8844	0.3470
age2	2	3.9457	0.1391
mat_yr	1	6.1894	0.0129
WFH	1	0.4213	0.5163
HFA	1	0.2372	0.6262
brfeed	1	0.8292	0.3625
e_crp*asset	4	7.2644	0.1226
e_crp*SEX	1	2.9082	0.0881
e_crp*mat_yr	1	2.0119	0.1561
e_crp*brfeed	1	2.9108	0.0880

Analysis of Maximum Likelihood Estimates					
Parameter		**DF**	**Estimate**	**Standard Error**	**Wald Chi-Square**	**Pr > ChiSq**
Intercept		1	-1.1791	0.5843	4.0721	0.0436
e_crp		1	2.9680	0.9414	9.9395	0.0016
asset	**0**	1	0.6308	0.4762	1.7545	0.1853
asset	**1**	1	0.1062	0.4447	0.0570	0.8113
asset	**2**	1	0.5061	0.3724	1.8470	0.1741

Analysis of Maximum Likelihood Estimates						
Parameter		**DF**	**Estimate**	**Standard Error**	**Wald Chi-Square**	**Pr > ChiSq**
asset	**3**	1	-0.1137	0.5572	0.0416	0.8383
SEX		1	0.2570	0.2733	0.8844	0.3470
age2	**1**	1	-0.5796	0.3009	3.7111	0.0541
age2	**2**	1	-0.2974	0.2130	1.9499	0.1626
mat_yr		1	-0.0373	0.0150	6.1894	0.0129
WFH		1	-0.4038	0.6220	0.4213	0.5163
HFA		1	0.1093	0.2243	0.2372	0.6262
brfeed		1	0.2639	0.2898	0.8292	0.3625
e_crp*asset	**0**	1	-0.5372	0.6476	0.6883	0.4068
e_crp*asset	**1**	1	-0.2309	0.6165	0.1403	0.7080
e_crp*asset	**2**	1	-0.9654	0.4743	4.1419	0.0418
e_crp*asset	**3**	1	0.2936	0.7644	0.1475	0.7009
e_crp*SEX		1	-0.6761	0.3965	2.9082	0.0881
e_crp*mat_yr		1	0.0350	0.0247	2.0119	0.1561
e_crp*brfeed		1	-0.7007	0.4107	2.9108	0.0880

```
*Drop e_crp*mat_yr, p=.1561;
Proc surveylogistic data=three;
   Cluster cluster;
   Class asset (REF='4') /param=ref;
   Class age2 (REF='3') /param=ref;
   Model malaria1 (Event='1') = e_crp asset sex age2 mat_yr wfh hfa
brfeed e_crp*asset e_crp*sex e_crp*brfeed;
   Contrast 'CRP' e_crp 1 / est=exp;
run;
```

Model Fit Statistics		
Criterion	**Intercept Only**	**Intercept and Covariates**
AIC	916.754	781.345
SC	921.338	868.430
-2 Log L	914.754	743.345

Testing Global Null Hypothesis: BETA=0			
Test	**Chi-Square**	**DF**	**Pr > ChiSq**

Testing Global Null Hypothesis: BETA=0			
Test	**Chi-Square**	**DF**	**Pr > ChiSq**
Likelihood Ratio	171.4090	18	<.0001
Score	169.4905	18	<.0001
Wald	181.8679	18	<.0001

Type 3 Analysis of Effects			
Effect	**DF**	**Wald Chi-Square**	**Pr > ChiSq**
e_crp	1	33.2572	<.0001
asset	4	7.9688	0.0927
SEX	1	1.0074	0.3155
age2	2	4.0629	0.1311
mat_yr	1	3.8325	0.0503
WFH	1	0.3485	0.5549
HFA	1	0.2454	0.6203
brfeed	1	0.8545	0.3553
e_crp*asset	4	8.5806	0.0725
e_crp*SEX	1	3.0631	0.0801
e_crp*brfeed	1	3.1684	0.0751

Analysis of Maximum Likelihood Estimates						
Parameter		**DF**	**Estimate**	**Standard Error**	**Wald Chi-Square**	**Pr > ChiSq**
Intercept		1	-1.6509	0.5281	9.7741	0.0018
e_crp		1	4.0225	0.6975	33.2572	<.0001
asset	**0**	1	0.6820	0.4688	2.1166	0.1457
asset	**1**	1	0.1276	0.4380	0.0848	0.7709
asset	**2**	1	0.5018	0.3705	1.8351	0.1755
asset	**3**	1	-0.1003	0.5536	0.0328	0.8562
SEX		1	0.2698	0.2688	1.0074	0.3155
age2	**1**	1	-0.5872	0.2979	3.8845	0.0487
age2	**2**	1	-0.2821	0.2088	1.8252	0.1767
mat_yr		1	-0.0207	0.0106	3.8325	0.0503
WFH		1	-0.3629	0.6147	0.3485	0.5549

Analysis of Maximum Likelihood Estimates

Parameter		DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
HFA		1	0.1102	0.2224	0.2454	0.6203
brfeed		1	0.2624	0.2839	0.8545	0.3553
e_crp*asset	**0**	1	-0.7236	0.6189	1.3669	0.2423
e_crp*asset	**1**	1	-0.3532	0.5936	0.3541	0.5518
e_crp*asset	**2**	1	-1.0825	0.4679	5.3533	0.0207
e_crp*asset	**3**	1	0.2194	0.7688	0.0815	0.7753
e_crp*SEX		1	-0.6874	0.3928	3.0631	0.0801
e_crp*brfeed		1	-0.7323	0.4114	3.1684	0.0751

```
*Drop e_crp*sex, p=.0801;
Proc surveylogistic data=three;
   Cluster cluster;
   Class asset (REF='4') /param=ref;
   Class age2 (REF='3') /param=ref;
   Model malaria1 (Event='1') = e_crp asset sex age2 mat_yr wfh hfa
brfeed e_crp*asset e_crp*brfeed;
   Contrast 'CRP' e_crp 1 / est=exp;
run;
```

Model Fit Statistics

Criterion	Intercept Only	Intercept and Covariates
AIC	916.754	782.827
SC	921.338	865.328
-2 Log L	914.754	746.827

Testing Global Null Hypothesis: BETA=0

Test	Chi-Square	DF	Pr > ChiSq
Likelihood Ratio	167.9277	17	<.0001
Score	166.3318	17	<.0001
Wald	191.5136	17	<.0001

Type 3 Analysis of Effects

Effect	DF	Wald Chi-Square	Pr > ChiSq

Type 3 Analysis of Effects			
Effect	**DF**	**Wald Chi-Square**	**Pr > ChiSq**
e_crp	1	45.1660	<.0001
asset	4	8.2214	0.0838
SEX	1	0.0395	0.8425
age2	2	4.0661	0.1309
mat_yr	1	4.2548	0.0391
WFH	1	0.2556	0.6132
HFA	1	0.2592	0.6107
brfeed	1	0.9549	0.3285
e_crp*asset	4	8.9142	0.0633
e_crp*brfeed	1	3.4450	0.0634

Analysis of Maximum Likelihood Estimates						
Parameter		**DF**	**Estimate**	**Standard Error**	**Wald Chi-Square**	**Pr > ChiSq**
Intercept		1	-1.1729	0.4277	7.5213	0.0061
e_crp		1	3.0219	0.4496	45.1660	<.0001
asset	**0**	1	0.6879	0.4693	2.1489	0.1427
asset	**1**	1	0.1162	0.4397	0.0698	0.7917
asset	**2**	1	0.4867	0.3683	1.7457	0.1864
asset	**3**	1	-0.1108	0.5566	0.0396	0.8422
SEX		1	-0.0363	0.1825	0.0395	0.8425
age2	**1**	1	-0.5875	0.2976	3.8979	0.0483
age2	**2**	1	-0.2819	0.2066	1.8605	0.1726
mat_yr		1	-0.0216	0.0105	4.2548	0.0391
WFH		1	-0.3122	0.6176	0.2556	0.6132
HFA		1	0.1145	0.2250	0.2592	0.6107
brfeed		1	0.2749	0.2813	0.9549	0.3285
e_crp*asset	**0**	1	-0.7555	0.6195	1.4873	0.2226
e_crp*asset	**1**	1	-0.3831	0.5991	0.4089	0.5225
e_crp*asset	**2**	1	-1.1131	0.4672	5.6757	0.0172
e_crp*asset	**3**	1	0.1501	0.7672	0.0383	0.8449
e_crp*brfeed		1	-0.7648	0.4120	3.4450	0.0634

```
*Drop e_crp*asset, p= .0633;
Proc surveylogistic data=three;
   Cluster cluster;
   Class asset (REF='4') /param=ref;
   Class age2 (REF='3') /param=ref;
   Model malaria1 (Event='1') = e_crp asset sex age2 mat_yr wfh hfa
brfeed e_crp*brfeed;
   Contrast 'CRP' e_crp 1 / est=exp;
run;
```

Model Fit Statistics

Criterion	Intercept Only	Intercept and Covariates
AIC	916.754	781.375
SC	921.338	845.542
-2 Log L	914.754	753.375

Testing Global Null Hypothesis: BETA=0

Test	Chi-Square	DF	Pr > ChiSq
Likelihood Ratio	161.3798	13	<.0001
Score	161.3046	13	<.0001
Wald	137.9319	13	<.0001

Type 3 Analysis of Effects

Effect	DF	Wald Chi-Square	Pr > ChiSq
e_crp	1	79.9857	<.0001
asset	4	3.1556	0.5321
SEX	1	0.0223	0.8813
age2	2	4.2630	0.1187
mat_yr	1	3.0050	0.0830
WFH	1	0.4903	0.4838
HFA	1	0.4384	0.5079
brfeed	1	0.9819	0.3217
e_crp*brfeed	1	3.4214	0.0644

Analysis of Maximum Likelihood Estimates

Parameter		DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept		1	-1.1137	0.3784	8.6615	0.0033
e_crp		1	2.5176	0.2815	79.9857	<.0001
asset	**0**	1	0.4222	0.3333	1.6048	0.2052
asset	**1**	1	-0.0172	0.3044	0.0032	0.9548
asset	**2**	1	0.0249	0.2902	0.0074	0.9315
asset	**3**	1	0.0495	0.3065	0.0261	0.8717
SEX		1	-0.0272	0.1824	0.0223	0.8813
age2	**1**	1	-0.5874	0.2931	4.0165	0.0451
age2	**2**	1	-0.3068	0.2083	2.1686	0.1409
mat_yr		1	-0.0172	0.00992	3.0050	0.0830
WFH		1	-0.4494	0.6417	0.4903	0.4838
HFA		1	0.1406	0.2123	0.4384	0.5079
brfeed		1	0.2846	0.2872	0.9819	0.3217
e_crp*brfeed		1	-0.7460	0.4033	3.4214	0.0644

Odds Ratio Estimates

Effect	Point Estimate	95% Wald Confidence Limits	
asset 0 vs 4	1.525	0.794	2.932
asset 1 vs 4	0.983	0.541	1.785
asset 2 vs 4	1.025	0.580	1.811
asset 3 vs 4	1.051	0.576	1.916
SEX	0.973	0.681	1.391
age2 1 vs 3	0.556	0.313	0.987
age2 2 vs 3	0.736	0.489	1.107
mat_yr	0.983	0.964	1.002
WFH	0.638	0.181	2.244
HFA	1.151	0.759	1.745

```
*model with no interaction terms;
Proc surveylogistic data=three;
   Cluster cluster;
   Class asset (REF='4') /param=ref;
   Class age2 (REF='3') /param=ref;
```

```
   Model malaria1 (Event='1') = e_crp asset sex age2 mat_yr wfh hfa
brfeed;
   Contrast 'CRP' e_crp 1 / est=exp;
run;
```

Model Fit Statistics

Criterion	Intercept Only	Intercept and Covariates
AIC	916.754	783.488
SC	921.338	843.072
-2 Log L	914.754	757.488

Testing Global Null Hypothesis: BETA=0

Test	Chi-Square	DF	Pr > ChiSq
Likelihood Ratio	157.2667	12	<.0001
Score	156.3520	12	<.0001
Wald	131.3950	12	<.0001

Type 3 Analysis of Effects

Effect	DF	Wald Chi-Square	Pr > ChiSq
e_crp	1	102.5177	<.0001
asset	4	3.0838	0.5439
SEX	1	0.0215	0.8833
age2	2	3.6322	0.1627
mat_yr	1	2.7663	0.0963
WFH	1	0.6416	0.4231
HFA	1	0.7439	0.3884
brfeed	1	0.0635	0.8011

Analysis of Maximum Likelihood Estimates

Parameter		DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept		1	-0.9983	0.3640	7.5214	0.0061
e_crp		1	2.1055	0.2079	102.5177	<.0001
asset	0	1	0.4120	0.3334	1.5269	0.2166

Analysis of Maximum Likelihood Estimates						
Parameter		**DF**	**Estimate**	**Standard Error**	**Wald Chi-Square**	**Pr > ChiSq**
asset	**1**	1	-0.0246	0.3058	0.0064	0.9360
asset	**2**	1	0.0288	0.2827	0.0103	0.9190
asset	**3**	1	0.0428	0.3057	0.0196	0.8885
SEX		1	-0.0267	0.1818	0.0215	0.8833
age2	**1**	1	-0.5640	0.3050	3.4185	0.0645
age2	**2**	1	-0.2778	0.2087	1.7719	0.1831
mat_yr		1	-0.0157	0.00944	2.7663	0.0963
WFH		1	-0.5266	0.6575	0.6416	0.4231
HFA		1	0.1742	0.2019	0.7439	0.3884
brfeed		1	-0.0547	0.2172	0.0635	0.8011

Odds Ratio Estimates			
Effect	**Point Estimate**	**95% Wald Confidence Limits**	
e_crp	8.211	5.463	12.343
asset 0 vs 4	1.510	0.785	2.902
asset 1 vs 4	0.976	0.536	1.777
asset 2 vs 4	1.029	0.591	1.791
asset 3 vs 4	1.044	0.573	1.900
SEX	0.974	0.682	1.390
age2 1 vs 3	0.569	0.313	1.034
age2 2 vs 3	0.757	0.503	1.140
mat_yr	0.984	0.966	1.003
WFH	0.591	0.163	2.143
HFA	1.190	0.801	1.768
brfeed	0.947	0.618	1.449

Association of Predicted Probabilities and Observed Responses			
Percent Concordant	76.4	**Somers' D**	0.532
Percent Discordant	23.2	**Gamma**	0.535
Percent Tied	0.5	**Tau-a**	0.235

Association of Predicted Probabilities and Observed Responses			
Pairs	115182	**c**	0.766

Contrast Test Results

Contrast	DF	Wald Chi-Square	Pr > ChiSq
CRP	1	102.5177	<.0001

Contrast Estimation and Testing Results by Row

Contrast	Type	Row	Estimate	Standard Error	Alpha	Confidence Limits		Wald Chi-Square	Pr > ChiSq
CRP	**EXP**	**1**	8.2113	1.7075	0.05	5.4627	12.3429	102.5177	<.0001

```
*Drop all covariates;
Proc surveylogistic data=three;
   Cluster cluster;
   Model malaria1 (Event='1') = e_crp;
   Contrast 'crp' e_crp 1 / est=exp;
run;
```

Model Convergence Status

Convergence criterion (GCONV=1E-8) satisfied.

Model Fit Statistics

Criterion	Intercept Only	Intercept and Covariates
AIC	1053.273	888.785
SC	1057.992	898.223
-2 Log L	1051.273	884.785

Testing Global Null Hypothesis: BETA=0

Test	Chi-Square	DF	Pr > ChiSq
Likelihood Ratio	166.4884	1	<.0001
Score	168.4463	1	<.0001
Wald	103.2725	1	<.0001

Analysis of Maximum Likelihood Estimates

Parameter	DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept	1	-1.5301	0.1301	138.3094	<.0001
e_crp	1	2.0428	0.2010	103.2725	<.0001

Odds Ratio Estimates

Effect	Point Estimate	95% Wald Confidence Limits	
e_crp	7.712	5.201	11.436

Association of Predicted Probabilities and Observed Responses

Percent Concordant	52.2	**Somers' D**	0.455
Percent Discordant	6.8	**Gamma**	0.770
Percent Tied	41.0	**Tau-a**	0.202
Pairs	151796	**c**	0.727

Contrast Test Results

Contrast	DF	Wald Chi-Square	Pr > ChiSq
crp	1	103.2725	<.0001

Contrast Estimation and Testing Results by Row

Contrast	Type	Row	Estimate	Standard Error	Alpha	Confidence Limits		Wald Chi-Square	Pr > ChiSq
crp	**EXP**	**1**	7.7120	1.5502	0.05	5.2007	11.4360	103.2725	<.0001

Exposure: Any inflammation Outcome: Diarrhea

```
*Full model with all interaction terms;
Proc surveylogistic data=three;
   Cluster cluster;
   Class asset (REF='4') /param=ref;
   Class age2 (REF='3') /param=ref;
   Model diarrhea24HR (Event='1') = inflam asset sex age2 mat_yr wfh
hfa brfeed inflam*asset inflam*sex inflam*age2 inflam*mat_yr inflam*wfh
inflam*hfa inflam*brfeed;
   Where diarrhea24HR = 0 or diarrhea24HR= 1;
   Contrast "inflammation" inflam 1/est=exp;
Run;
```

Model Fit Statistics		
Criterion	**Intercept Only**	**Intercept and Covariates**
AIC	838.431	835.929
SC	843.032	946.358
-2 Log L	836.431	787.929

Testing Global Null Hypothesis: BETA=0			
Test	**Chi-Square**	**DF**	**Pr > ChiSq**
Likelihood Ratio	48.5022	23	0.0014
Score	47.6900	23	0.0018
Wald	79.6403	23	<.0001

Type 3 Analysis of Effects			
Effect	**DF**	**Wald Chi-Square**	**Pr > ChiSq**
inflam	1	1.5892	0.2074
asset	4	4.6860	0.3211
SEX	1	1.3030	0.2537
age2	2	0.1568	0.9246
mat_yr	1	6.3994	0.0114
WFH	1	0.5355	0.4643
HFA	1	0.4422	0.5061
brfeed	1	0.0393	0.8428
inflam*asset	4	4.7605	0.3128
inflam*SEX	1	2.4143	0.1202
inflam*age2	2	0.5748	0.7502
inflam*mat_yr	1	1.5326	0.2157
inflam*WFH	1	0.1292	0.7193
inflam*HFA	1	0.0221	0.8819
inflam*brfeed	1	1.2370	0.2661

Analysis of Maximum Likelihood Estimates					
Parameter	**DF**	**Estimate**	**Standard Error**	**Wald Chi-Square**	**Pr > ChiSq**

Analysis of Maximum Likelihood Estimates						
Parameter		**DF**	**Estimate**	**Standard Error**	**Wald Chi-Square**	**Pr > ChiSq**
Intercept		1	0.2759	0.9087	0.0922	0.7614
inflam		1	-1.4532	1.1527	1.5892	0.2074
asset	**0**	1	-0.1291	0.5699	0.0513	0.8208
asset	**1**	1	0.1284	0.4578	0.0787	0.7791
asset	**2**	1	0.5874	0.4609	1.6245	0.2025
asset	**3**	1	-0.1789	0.5804	0.0950	0.7580
SEX		1	-0.3585	0.3140	1.3030	0.2537
age2	**1**	1	0.1848	0.5123	0.1302	0.7183
age2	**2**	1	-0.0112	0.3239	0.0012	0.9724
mat_yr		1	-0.0550	0.0217	6.3994	0.0114
WFH		1	0.8307	1.1351	0.5355	0.4643
HFA		1	0.2678	0.4027	0.4422	0.5061
brfeed		1	-0.0666	0.3356	0.0393	0.8428
inflam*asset	**0**	1	0.2083	0.6740	0.0955	0.7573
inflam*asset	**1**	1	0.0654	0.5931	0.0122	0.9122
inflam*asset	**2**	1	-0.8552	0.5537	2.3854	0.1225
inflam*asset	**3**	1	-0.3086	0.7611	0.1643	0.6852
inflam*SEX		1	0.5880	0.3784	2.4143	0.1202
inflam*age2	**1**	1	0.5056	0.6675	0.5737	0.4488
inflam*age2	**2**	1	0.1274	0.4062	0.0984	0.7538
inflam*mat_yr		1	0.0367	0.0296	1.5326	0.2157
inflam*WFH		1	-0.4484	1.2476	0.1292	0.7193
inflam*HFA		1	0.0743	0.5003	0.0221	0.8819
inflam*brfeed		1	0.4780	0.4298	1.2370	0.2661

Association of Predicted Probabilities and Observed Responses			
Percent Concordant	66.4	**Somers' D**	0.332
Percent Discordant	33.1	**Gamma**	0.334
Percent Tied	0.5	**Tau-a**	0.127
Pairs	103024	**c**	0.666

Contrast Test Results			
Contrast	**DF**	**Wald Chi-Square**	**Pr > ChiSq**
inflammation	1	1.5892	0.2074

Contrast Estimation and Testing Results by Row									
Contrast	**Type**	**Row**	**Estimate**	**Standard Error**	**Alpha**	**Confidence Limits**		**Wald Chi-Square**	**Pr > ChiSq**
inflammation	**EXP**	**1**	0.2338	0.2695	0.05	0.0244	2.2393	1.5892	0.2074

```
*Drop inflam*hfa p=.8819;
Proc surveylogistic data=three;
   Cluster cluster;
   Class asset (REF='4') /param=ref;
   Class age2 (REF='3') /param=ref;
   Model diarrhea24HR (Event='1') = inflam asset sex age2 mat_yr wfh
hfa brfeed inflam*asset inflam*sex inflam*age2 inflam*mat_yr inflam*wfh
inflam*brfeed;
   Where diarrhea24HR = 0 or diarrhea24HR= 1;
   Contrast "inflammation" inflam 1/est=exp;
run;
```

Model Fit Statistics		
Criterion	**Intercept Only**	**Intercept and Covariates**
AIC	838.431	833.957
SC	843.032	939.785
-2 Log L	836.431	787.957

Testing Global Null Hypothesis: BETA=0			
Test	**Chi-Square**	**DF**	**Pr > ChiSq**
Likelihood Ratio	48.4741	22	0.0009
Score	47.6316	22	0.0012
Wald	78.4511	22	<.0001

Type 3 Analysis of Effects			
Effect	**DF**	**Wald Chi-Square**	**Pr > ChiSq**
inflam	1	1.4625	0.2265
asset	4	4.6890	0.3207

Type 3 Analysis of Effects			
Effect	**DF**	**Wald Chi-Square**	**Pr > ChiSq**
SEX	1	1.2572	0.2622
age2	2	0.1721	0.9175
mat_yr	1	6.3000	0.0121
WFH	1	0.5421	0.4615
HFA	1	2.1158	0.1458
brfeed	1	0.0408	0.8400
inflam*asset	4	4.7828	0.3103
inflam*SEX	1	2.2721	0.1317
inflam*age2	2	0.5328	0.7661
inflam*mat_yr	1	1.5067	0.2196
inflam*WFH	1	0.1267	0.7219
inflam*brfeed	1	1.2432	0.2648

Analysis of Maximum Likelihood Estimates						
Parameter		**DF**	**Estimate**	**Standard Error**	**Wald Chi-Square**	**Pr > ChiSq**
Intercept		1	0.2416	0.9101	0.0705	0.7907
inflam		1	-1.4104	1.1663	1.4625	0.2265
asset	**0**	1	-0.1282	0.5699	0.0506	0.8220
asset	**1**	1	0.1252	0.4565	0.0753	0.7838
asset	**2**	1	0.5859	0.4590	1.6293	0.2018
asset	**3**	1	-0.1807	0.5779	0.0978	0.7545
SEX		1	-0.3517	0.3137	1.2572	0.2622
age2	**1**	1	0.1970	0.5128	0.1476	0.7009
age2	**2**	1	-0.00967	0.3224	0.0009	0.9761
mat_yr		1	-0.0546	0.0217	6.3000	0.0121
WFH		1	0.8231	1.1179	0.5421	0.4615
HFA		1	0.3182	0.2188	2.1158	0.1458
brfeed		1	-0.0677	0.3354	0.0408	0.8400
inflam*asset	**0**	1	0.2100	0.6720	0.0976	0.7547
inflam*asset	**1**	1	0.0722	0.5932	0.0148	0.9031
inflam*asset	**2**	1	-0.8536	0.5530	2.3831	0.1227

Analysis of Maximum Likelihood Estimates						
Parameter		**DF**	**Estimate**	**Standard Error**	**Wald Chi-Square**	**Pr > ChiSq**
inflam*asset	**3**	1	-0.3058	0.7582	0.1626	0.6868
inflam*SEX		1	0.5788	0.3840	2.2721	0.1317
inflam*age2	**1**	1	0.4868	0.6675	0.5318	0.4658
inflam*age2	**2**	1	0.1220	0.4060	0.0903	0.7638
inflam*mat_yr		1	0.0364	0.0297	1.5067	0.2196
inflam*WFH		1	-0.4373	1.2288	0.1267	0.7219
inflam*brfeed		1	0.4771	0.4279	1.2432	0.2648

```
*Drop inflam*age2, p=.7661;
Proc surveylogistic data=three;
   Cluster cluster;
   Class asset (REF='4') /param=ref;
   Class age2 (REF='3') /param=ref;
   Model diarrhea24HR (Event='1') = inflam asset sex age2 mat_yr wfh
hfa brfeed inflam*asset inflam*sex inflam*wfh inflam*mat_yr
inflam*brfeed;
   Where diarrhea24HR = 0 or diarrhea24HR= 1;
   Contrast "inflammation" inflam 1/est=exp;
run;
```

Model Fit Statistics		
Criterion	**Intercept Only**	**Intercept and Covariates**
AIC	838.431	830.568
SC	843.032	927.194
-2 Log L	836.431	788.568

Testing Global Null Hypothesis: BETA=0			
Test	**Chi-Square**	**DF**	**Pr > ChiSq**
Likelihood Ratio	47.8624	20	0.0004
Score	46.4598	20	0.0007
Wald	76.0622	20	<.0001

Type 3 Analysis of Effects			
Effect	**DF**	**Wald Chi-Square**	**Pr > ChiSq**

Type 3 Analysis of Effects			
Effect	**DF**	**Wald Chi-Square**	**Pr > ChiSq**
inflam	1	1.3624	0.2431
asset	4	5.1752	0.2698
SEX	1	1.3796	0.2402
age2	2	4.9918	0.0824
mat_yr	1	5.9024	0.0151
WFH	1	0.4673	0.4942
HFA	1	2.1365	0.1438
brfeed	1	0.3435	0.5578
inflam*asset	4	4.9627	0.2911
inflam*SEX	1	2.4017	0.1212
inflam*WFH	1	0.0992	0.7527
inflam*mat_yr	1	1.3766	0.2407
inflam*brfeed	1	3.1476	0.0760

Analysis of Maximum Likelihood Estimates						
Parameter		**DF**	**Estimate**	**Standard Error**	**Wald Chi-Square**	**Pr > ChiSq**
Intercept		1	0.2157	0.9137	0.0557	0.8134
inflam		1	-1.3586	1.1639	1.3624	0.2431
asset	**0**	1	-0.1357	0.5721	0.0563	0.8125
asset	**1**	1	0.1215	0.4536	0.0718	0.7888
asset	**2**	1	0.5914	0.4587	1.6622	0.1973
asset	**3**	1	-0.2161	0.5869	0.1356	0.7127
SEX		1	-0.3666	0.3121	1.3796	0.2402
age2	**1**	1	0.5404	0.2627	4.2310	0.0397
age2	**2**	1	0.0751	0.2111	0.1266	0.7220
mat_yr		1	-0.0536	0.0221	5.9024	0.0151
WFH		1	0.7998	1.1700	0.4673	0.4942
HFA		1	0.3193	0.2185	2.1365	0.1438
brfeed		1	-0.1913	0.3264	0.3435	0.5578
inflam*asset	**0**	1	0.2200	0.6720	0.1072	0.7433
inflam*asset	**1**	1	0.0716	0.5905	0.0147	0.9035

Analysis of Maximum Likelihood Estimates

Parameter		DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
inflam*asset	**2**	1	-0.8616	0.5529	2.4286	0.1191
inflam*asset	**3**	1	-0.2532	0.7630	0.1101	0.7400
inflam*SEX		1	0.5911	0.3814	2.4017	0.1212
inflam*WFH		1	-0.4012	1.2736	0.0992	0.7527
inflam*mat_yr		1	0.0350	0.0298	1.3766	0.2407
inflam*brfeed		1	0.6541	0.3687	3.1476	0.0760

```
*Drop inflam*wfh, p=.7527;
Proc surveylogistic data=three;
   Cluster cluster;
   Class asset (REF='4') /param=ref;
   Class age2 (REF='3') /param=ref;
   Model diarrhea24HR (Event='1') = inflam asset sex age2 mat_yr wfh
hfa brfeed inflam*asset inflam*sex inflam*mat_yr inflam*brfeed;
   Where diarrhea24HR = 0 or diarrhea24HR= 1;
   Contrast "inflammation" inflam 1/est=exp;
run;
```

Model Fit Statistics

Criterion	Intercept Only	Intercept and Covariates
AIC	838.431	828.657
SC	843.032	920.681
-2 Log L	836.431	788.657

Testing Global Null Hypothesis: BETA=0

Test	Chi-Square	DF	Pr > ChiSq
Likelihood Ratio	47.7743	19	0.0003
Score	46.4426	19	0.0004
Wald	68.8808	19	<.0001

Type 3 Analysis of Effects

Effect	DF	Wald Chi-Square	Pr > ChiSq
inflam	1	1.3380	0.2474
asset	4	5.1614	0.2711

Type 3 Analysis of Effects

Effect	DF	Wald Chi-Square	Pr > ChiSq
SEX	1	1.3852	0.2392
age2	2	4.9649	0.0835
mat_yr	1	5.8642	0.0155
WFH	1	1.0223	0.3120
HFA	1	2.1488	0.1427
brfeed	1	0.3257	0.5682
inflam*asset	4	4.9731	0.2901
inflam*SEX	1	2.4123	0.1204
inflam*mat_yr	1	1.3514	0.2450
inflam*brfeed	1	3.0637	0.0801

Analysis of Maximum Likelihood Estimates

Parameter		DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept		1	0.2055	0.9156	0.0504	0.8224
inflam		1	-1.3486	1.1659	1.3380	0.2474
asset	**0**	1	-0.1347	0.5731	0.0552	0.8142
asset	**1**	1	0.1295	0.4504	0.0827	0.7737
asset	**2**	1	0.5966	0.4630	1.6604	0.1976
asset	**3**	1	-0.2039	0.5819	0.1228	0.7260
SEX		1	-0.3672	0.3120	1.3852	0.2392
age2	**1**	1	0.5393	0.2641	4.1693	0.0412
age2	**2**	1	0.0734	0.2113	0.1208	0.7282
mat_yr		1	-0.0532	0.0220	5.8642	0.0155
WFH		1	0.4436	0.4388	1.0223	0.3120
HFA		1	0.3193	0.2178	2.1488	0.1427
brfeed		1	-0.1879	0.3293	0.3257	0.5682
inflam*asset	**0**	1	0.2145	0.6752	0.1009	0.7507
inflam*asset	**1**	1	0.0631	0.5841	0.0117	0.9140
inflam*asset	**2**	1	-0.8704	0.5567	2.4447	0.1179
inflam*asset	**3**	1	-0.2654	0.7578	0.1226	0.7262
inflam*SEX		1	0.5922	0.3813	2.4123	0.1204

Analysis of Maximum Likelihood Estimates					
Parameter	**DF**	**Estimate**	**Standard Error**	**Wald Chi-Square**	**Pr > ChiSq**
inflam*mat_yr	1	0.0346	0.0298	1.3514	0.2450
inflam*brfeed	1	0.6494	0.3710	3.0637	0.0801

```
*Drop inflam*asset, p=.2901;
Proc surveylogistic data=three;
   Cluster cluster;
   Class asset (REF='4') /param=ref;
   Class age2 (REF='3') /param=ref;
   Model diarrhea24HR (Event='1') = inflam asset sex age2 mat_yr wfh
hfa brfeed inflam*sex inflam*mat_yr inflam*brfeed;
   Where diarrhea24HR = 0 or diarrhea24HR= 1;
   Contrast "inflammation" inflam 1/est=exp;
run;
```

Model Fit Statistics		
Criterion	**Intercept Only**	**Intercept and Covariates**
AIC	838.431	825.582
SC	843.032	899.202
-2 Log L	836.431	793.582

Testing Global Null Hypothesis: BETA=0			
Test	**Chi-Square**	**DF**	**Pr > ChiSq**
Likelihood Ratio	42.8485	15	0.0002
Score	41.6363	15	0.0003
Wald	52.6780	15	<.0001

Type 3 Analysis of Effects			
Effect	**DF**	**Wald Chi-Square**	**Pr > ChiSq**
inflam	1	2.0503	0.1522
asset	4	4.7011	0.3194
SEX	1	1.5300	0.2161
age2	2	4.9136	0.0857
mat_yr	1	5.0512	0.0246

Type 3 Analysis of Effects

Effect	DF	Wald Chi-Square	Pr > ChiSq
WFH	1	1.0216	0.3121
HFA	1	2.4952	0.1142
brfeed	1	0.3952	0.5296
inflam*SEX	1	2.6010	0.1068
inflam*mat_yr	1	1.0544	0.3045
inflam*brfeed	1	3.7431	0.0530

Analysis of Maximum Likelihood Estimates

Parameter		DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept		1	0.2744	0.8585	0.1022	0.7492
inflam		1	-1.5300	1.0685	2.0503	0.1522
asset	**0**	1	0.0719	0.3354	0.0460	0.8301
asset	**1**	1	0.1972	0.2827	0.4866	0.4854
asset	**2**	1	0.0590	0.3233	0.0333	0.8551
asset	**3**	1	-0.3681	0.3214	1.3117	0.2521
SEX		1	-0.3781	0.3056	1.5300	0.2161
age2	**1**	1	0.5369	0.2655	4.0895	0.0432
age2	**2**	1	0.0640	0.2136	0.0898	0.7644
mat_yr		1	-0.0492	0.0219	5.0512	0.0246
WFH		1	0.4134	0.4090	1.0216	0.3121
HFA		1	0.3412	0.2160	2.4952	0.1142
brfeed		1	-0.2045	0.3252	0.3952	0.5296
inflam*SEX		1	0.6048	0.3750	2.6010	0.1068
inflam*mat_yr		1	0.0305	0.0297	1.0544	0.3045
inflam*brfeed		1	0.6957	0.3596	3.7431	0.0530

```
*Drop inflam*mat_yr, p=.3045;
Proc surveylogistic data=three;
   Cluster cluster;
   Class asset (REF='4') /param=ref;
   Class age2 (REF='3') /param=ref;
   Model diarrhea24HR (Event='1') = inflam asset sex age2 mat_yr wfh
hfa brfeed inflam*sex inflam*brfeed;
    Where diarrhea24HR = 0 or diarrhea24HR= 1;
   Contrast "inflammation" inflam 1/est=exp;
run;
```

Model Fit Statistics		
Criterion	**Intercept Only**	**Intercept and Covariates**
AIC	838.431	824.820
SC	843.032	893.838
-2 Log L	836.431	794.820

Testing Global Null Hypothesis: BETA=0			
Test	**Chi-Square**	**DF**	**Pr > ChiSq**
Likelihood Ratio	41.6111	14	0.0001
Score	41.2792	14	0.0002
Wald	52.2522	14	<.0001

Type 3 Analysis of Effects			
Effect	**DF**	**Wald Chi-Square**	**Pr > ChiSq**
inflam	1	1.5172	0.2180
asset	4	4.5440	0.3374
SEX	1	1.4340	0.2311
age2	2	4.9698	0.0833
mat_yr	1	5.9908	0.0144
WFH	1	0.9493	0.3299
HFA	1	2.9446	0.0862
brfeed	1	0.3826	0.5362
inflam*SEX	1	2.4867	0.1148
inflam*brfeed	1	3.7006	0.0544

Analysis of Maximum Likelihood Estimates					
Parameter		**DF**	**Estimate**	**Standard Error**	**Wald Chi-Square**	**Pr > ChiSq**
Intercept		1	-0.2849	0.6252	0.2076	0.6486
inflam		1	-0.6866	0.5574	1.5172	0.2180
asset	**0**	1	0.0604	0.3345	0.0326	0.8567
asset	**1**	1	0.1833	0.2858	0.4111	0.5214
asset	**2**	1	0.0459	0.3237	0.0201	0.8872

Analysis of Maximum Likelihood Estimates

Parameter		DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
asset	**3**	1	-0.3733	0.3227	1.3384	0.2473
SEX		1	-0.3526	0.2945	1.4340	0.2311
age2	**1**	1	0.5493	0.2638	4.3347	0.0373
age2	**2**	1	0.0873	0.2147	0.1653	0.6843
mat_yr		1	-0.0296	0.0121	5.9908	0.0144
WFH		1	0.3951	0.4055	0.9493	0.3299
HFA		1	0.3676	0.2142	2.9446	0.0862
brfeed		1	-0.1948	0.3150	0.3826	0.5362
inflam*SEX		1	0.5733	0.3636	2.4867	0.1148
inflam*brfeed		1	0.6809	0.3539	3.7006	0.0544

```
*Drop inflam*sex, p=.1148;
Proc surveylogistic data=three;
   Cluster cluster;
   Class asset (REF='4') /param=ref;
   Class age2 (REF='3') /param=ref;
   Model diarrhea24HR (Event='1') = inflam asset sex age2 mat_yr wfh
hfa brfeed inflam*brfeed;
   Where diarrhea24HR = 0 or diarrhea24HR= 1;
   Contrast "inflammation" inflam 1/est=exp;
run;
```

Model Fit Statistics

Criterion	Intercept Only	Intercept and Covariates
AIC	838.431	825.118
SC	843.032	889.535
-2 Log L	836.431	797.118

Testing Global Null Hypothesis: BETA=0

Test	Chi-Square	DF	Pr > ChiSq
Likelihood Ratio	39.3129	13	0.0002
Score	39.2152	13	0.0002
Wald	43.4448	13	<.0001

Type 3 Analysis of Effects

Effect	DF	Wald Chi-Square	Pr > ChiSq
inflam	1	0.2595	0.6104
asset	4	4.2154	0.3776
SEX	1	0.0429	0.8359
age2	2	4.7343	0.0937
mat_yr	1	5.7849	0.0162
WFH	1	0.9398	0.3323
HFA	1	2.9368	0.0866
brfeed	1	0.4064	0.5238
inflam*brfeed	1	4.0373	0.0445

Analysis of Maximum Likelihood Estimates

Parameter		DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept		1	-0.8721	0.5180	2.8338	0.0923
inflam		1	0.1368	0.2685	0.2595	0.6104
asset	**0**	1	0.1076	0.3332	0.1044	0.7467
asset	**1**	1	0.2028	0.2808	0.5216	0.4702
asset	**2**	1	0.0758	0.3207	0.0559	0.8131
asset	**3**	1	-0.3338	0.3235	1.0648	0.3021
SEX		1	0.0362	0.1748	0.0429	0.8359
age2	**1**	1	0.5313	0.2600	4.1747	0.0410
age2	**2**	1	0.0856	0.2151	0.1583	0.6908
mat_yr		1	-0.0292	0.0121	5.7849	0.0162
WFH		1	0.3888	0.4010	0.9398	0.3323
HFA		1	0.3716	0.2168	2.9368	0.0866
brfeed		1	-0.1992	0.3125	0.4064	0.5238
inflam*brfeed		1	0.7049	0.3508	4.0373	0.0445

```
*Model without interaction terms;
Proc surveylogistic data=three;
   Cluster cluster;
   Class asset (REF='4') /param=ref;
   Class age2 (REF='3')/param=ref;
```

```
   Model diarrhea24HR (Event='1') = inflam asset sex age2 mat_yr wfh
hfa brfeed;
   Where diarrhea24HR = 0 or diarrhea24HR= 1;
   Contrast "inflammation" inflam 1/est=exp;
run;
```

Model Fit Statistics

Criterion	Intercept Only	Intercept and Covariates
AIC	838.431	826.589
SC	843.032	886.405
-2 Log L	836.431	800.589

Testing Global Null Hypothesis: BETA=0

Test	Chi-Square	DF	Pr > ChiSq
Likelihood Ratio	35.8419	12	0.0003
Score	34.8502	12	0.0005
Wald	37.1817	12	0.0002

Type 3 Analysis of Effects

Effect	DF	Wald Chi-Square	Pr > ChiSq
inflam	1	9.4571	0.0021
asset	4	4.1254	0.3893
SEX	1	0.0554	0.8139
age2	2	4.8956	0.0865
mat_yr	1	5.5521	0.0185
WFH	1	1.2068	0.2720
HFA	1	2.7137	0.0995
brfeed	1	1.5686	0.2104

Analysis of Maximum Likelihood Estimates

Parameter	DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept	1	-1.1588	0.5067	5.2295	0.0222
inflam	1	0.5513	0.1793	9.4571	0.0021

Analysis of Maximum Likelihood Estimates						
Parameter		**DF**	**Estimate**	**Standard Error**	**Wald Chi-Square**	**Pr > ChiSq**
asset	**0**	1	0.1032	0.3300	0.0978	0.7545
asset	**1**	1	0.1895	0.2778	0.4652	0.4952
asset	**2**	1	0.0584	0.3198	0.0334	0.8550
asset	**3**	1	-0.3343	0.3209	1.0848	0.2976
SEX		1	0.0405	0.1722	0.0554	0.8139
age2	**1**	1	0.5229	0.2560	4.1709	0.0411
age2	**2**	1	0.0789	0.2140	0.1359	0.7124
mat_yr		1	-0.0285	0.0121	5.5521	0.0185
WFH		1	0.4264	0.3882	1.2068	0.2720
HFA		1	0.3467	0.2105	2.7137	0.0995
brfeed		1	0.2778	0.2218	1.5686	0.2104

Odds Ratio Estimates			
Effect	**Point Estimate**	**95% Wald Confidence Limits**	
inflam	1.735	1.221	2.466
asset 0 vs 4	1.109	0.581	2.117
asset 1 vs 4	1.209	0.701	2.083
asset 2 vs 4	1.060	0.566	1.984
asset 3 vs 4	0.716	0.382	1.343
SEX	1.041	0.743	1.459
age2 1 vs 3	1.687	1.021	2.786
age2 2 vs 3	1.082	0.711	1.646
mat_yr	0.972	0.949	0.995
WFH	1.532	0.716	3.278
HFA	1.414	0.936	2.137
brfeed	1.320	0.855	2.039

Association of Predicted Probabilities and Observed Responses			
Percent Concordant	64.6	**Somers' D**	0.297
Percent Discordant	34.9	**Gamma**	0.299

Association of Predicted Probabilities and Observed Responses			
Percent Tied	0.6	**Tau-a**	0.113
Pairs	103024	**c**	0.648

Contrast Test Results			
Contrast	**DF**	**Wald Chi-Square**	**Pr > ChiSq**
inflammation	1	9.4571	0.0021

Contrast Estimation and Testing Results by Row									
Contrast	**Type**	**Row**	**Estimate**	**Standard Error**	**Alpha**	**Confidence Limits**		**Wald Chi-Square**	**Pr > ChiSq**
inflammation	**EXP**	**1**	1.7355	0.3111	0.05	1.2213	2.4661	9.4571	0.0021

```
*Drop all covariates;
Proc surveylogistic data=three;
   Cluster cluster;
   Model diarrhea24HR (Event='1') = inflam;
   Where diarrhea24HR = 0 or diarrhea24HR= 1;
   Contrast "inflammation" inflam 1/est=exp;
run;
```

Model Fit Statistics		
Criterion	**Intercept Only**	**Intercept and Covariates**
AIC	920.397	912.457
SC	925.113	921.887
-2 Log L	918.397	908.457

Testing Global Null Hypothesis: BETA=0			
Test	**Chi-Square**	**DF**	**Pr > ChiSq**
Likelihood Ratio	9.9409	1	0.0016
Score	9.6713	1	0.0019
Wald	10.1683	1	0.0014

Analysis of Maximum Likelihood Estimates

Parameter	DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept	1	-1.4808	0.1464	102.2739	<.0001
inflam	1	0.5426	0.1701	10.1683	0.0014

Odds Ratio Estimates

Effect	Point Estimate	95% Wald Confidence Limits	
inflam	1.720	1.233	2.401

Association of Predicted Probabilities and Observed Responses

Percent Concordant	29.2	**Somers' D**	0.122
Percent Discordant	17.0	**Gamma**	0.265
Percent Tied	53.9	**Tau-a**	0.045
Pairs	125846	**c**	0.561

Contrast Test Results

Contrast	DF	Wald Chi-Square	Pr > ChiSq
inflammation	1	10.1683	0.0014

Contrast Estimation and Testing Results by Row

Contrast	Type	Row	Estimate	Standard Error	Alpha	Confidence Limits		Wald Chi-Square	Pr > ChiSq
inflammation	**EXP**	**1**	1.7204	0.2927	0.05	1.2325	2.4013	10.1683	0.0014

Exposure: Elevated AGP Outcome: Fever

```
*Full model with interaction terms;

Proc surveylogistic data=three;
   Cluster cluster;
   Class asset (REF='4') /param=ref;
   Class age2 (REF='3') /param=ref;
   Model fever24HR (Event='1') = e_agp asset sex age2 mat_yr wfh hfa
brfeed e_agp*asset e_agp*sex e_agp*age2 e_agp*mat_yr e_agp*wfh
e_agp*hfa e_agp*brfeed;
   Where fever24HR = 0 or fever24HR= 1;
   Contrast "AGP" e_agp 1/est=exp;
run;
```

Model Fit Statistics		
Criterion	**Intercept Only**	**Intercept and Covariates**
AIC	997.356	977.088
SC	1001.949	1087.321
-2 Log L	995.356	929.088

Testing Global Null Hypothesis: BETA=0			
Test	**Chi-Square**	**DF**	**Pr > ChiSq**
Likelihood Ratio	66.2683	23	<.0001
Score	63.6540	23	<.0001
Wald	103.3244	23	<.0001

Type 3 Analysis of Effects			
Effect	**DF**	**Wald Chi-Square**	**Pr > ChiSq**
e_agp	1	0.0111	0.9162
asset	4	0.3837	0.9838
SEX	1	0.3574	0.5500
age2	2	3.8441	0.1463
mat_yr	1	1.5996	0.2060
WFH	1	0.0257	0.8727
HFA	1	1.2614	0.2614
brfeed	1	0.0238	0.8774
e_agp*asset	4	1.9346	0.7478
e_agp*SEX	1	0.1748	0.6758
e_agp*age2	2	2.1740	0.3372
e_agp*mat_yr	1	0.5428	0.4613
e_agp*WFH	1	0.0653	0.7983
e_agp*HFA	1	0.0910	0.7629
e_agp*brfeed	1	1.2642	0.2609

Analysis of Maximum Likelihood Estimates					
Parameter	**DF**	**Estimate**	**Standard Error**	**Wald Chi-Square**	**Pr > ChiSq**

Analysis of Maximum Likelihood Estimates

Parameter		DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept		1	0.0854	0.8758	0.0095	0.9223
e_agp		1	-0.1118	1.0620	0.0111	0.9162
asset	**0**	1	-0.0707	0.4846	0.0213	0.8840
asset	**1**	1	-0.2292	0.4607	0.2475	0.6188
asset	**2**	1	-0.0974	0.4453	0.0478	0.8269
asset	**3**	1	0.0655	0.3627	0.0326	0.8567
SEX		1	-0.1545	0.2584	0.3574	0.5500
age2	**1**	1	0.2092	0.4608	0.2061	0.6498
age2	**2**	1	-0.4453	0.3638	1.4979	0.2210
mat_yr		1	-0.0245	0.0194	1.5996	0.2060
WFH		1	0.1901	1.1863	0.0257	0.8727
HFA		1	0.3814	0.3395	1.2614	0.2614
brfeed		1	-0.0511	0.3311	0.0238	0.8774
e_agp*asset	**0**	1	0.5337	0.6218	0.7368	0.3907
e_agp*asset	**1**	1	0.0246	0.5222	0.0022	0.9624
e_agp*asset	**2**	1	-0.0824	0.5770	0.0204	0.8865
e_agp*asset	**3**	1	-0.2559	0.5383	0.2260	0.6345
e_agp*SEX		1	0.1269	0.3035	0.1748	0.6758
e_agp*age2	**1**	1	-0.1486	0.5452	0.0743	0.7852
e_agp*age2	**2**	1	0.4470	0.4648	0.9250	0.3362
e_agp*mat_yr		1	0.0194	0.0264	0.5428	0.4613
e_agp*WFH		1	0.3192	1.2491	0.0653	0.7983
e_agp*HFA		1	-0.1192	0.3952	0.0910	0.7629
e_agp*brfeed		1	0.4824	0.4291	1.2642	0.2609

Association of Predicted Probabilities and Observed Responses

Percent Concordant	66.9	**Somers' D**	0.342
Percent Discordant	32.7	**Gamma**	0.344
Percent Tied	0.5	**Tau-a**	0.167
Pairs	130200	**c**	0.671

Contrast Test Results			
Contrast	**DF**	**Wald Chi-Square**	**Pr > ChiSq**
AGP	1	0.0111	0.9162

Contrast Estimation and Testing Results by Row								
Contrast	**Type**	**Row**	**Estimate**	**Standard Error**	**Alpha**	**Confidence Limits**		**Wald Chi-Square**	**Pr > ChiSq**
AGP	**EXP**	**1**	0.8943	0.9497	0.05	0.1116	7.1680	0.0111	0.9162

```
*Drop e_agp*wfh, p=.7629;
Proc surveylogistic data=three;
   Cluster cluster;
   Class asset (REF='4') /param=ref;
   Class age2 (REF='3') /param=ref;
   Model fever24HR (Event='1') = e_agp asset sex age2 mat_yr wfh hfa
brfeed e_agp*asset e_agp*sex e_agp*age2 e_agp*mat_yr e_agp*hfa
e_agp*brfeed;
   Where fever24HR = 0 or fever24HR= 1;
   Contrast "AGP" e_agp 1/est=exp;
run;
```

Model Fit Statistics		
Criterion	**Intercept Only**	**Intercept and Covariates**
AIC	997.356	975.145
SC	1001.949	1080.785
-2 Log L	995.356	929.145

Testing Global Null Hypothesis: BETA=0			
Test	**Chi-Square**	**DF**	**Pr > ChiSq**
Likelihood Ratio	66.2111	22	<.0001
Score	63.5979	22	<.0001
Wald	87.0480	22	<.0001

Type 3 Analysis of Effects			
Effect	**DF**	**Wald Chi-Square**	**Pr > ChiSq**
e_agp	1	0.0120	0.9129

Type 3 Analysis of Effects

Effect	DF	Wald Chi-Square	Pr > ChiSq
asset	4	0.3829	0.9839
SEX	1	0.3521	0.5529
age2	2	3.7831	0.1508
mat_yr	1	1.6134	0.2040
WFH	1	1.4216	0.2331
HFA	1	1.2409	0.2653
brfeed	1	0.0257	0.8727
e_agp*asset	4	1.9018	0.7538
e_agp*SEX	1	0.1727	0.6777
e_agp*age2	2	2.1447	0.3422
e_agp*mat_yr	1	0.5476	0.4593
e_agp*HFA	1	0.0852	0.7704
e_agp*brfeed	1	1.2763	0.2586

Analysis of Maximum Likelihood Estimates

Parameter		DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept		1	0.0900	0.8774	0.0105	0.9183
e_agp		1	-0.1164	1.0634	0.0120	0.9129
asset	**0**	1	-0.0709	0.4840	0.0215	0.8835
asset	**1**	1	-0.2333	0.4585	0.2589	0.6109
asset	**2**	1	-0.1014	0.4433	0.0523	0.8191
asset	**3**	1	0.0596	0.3648	0.0267	0.8702
SEX		1	-0.1539	0.2593	0.3521	0.5529
age2	**1**	1	0.2061	0.4593	0.2013	0.6537
age2	**2**	1	-0.4449	0.3621	1.5091	0.2193
mat_yr		1	-0.0247	0.0194	1.6134	0.2040
WFH		1	0.4667	0.3914	1.4216	0.2331
HFA		1	0.3791	0.3403	1.2409	0.2653
brfeed		1	-0.0529	0.3302	0.0257	0.8727
e_agp*asset	**0**	1	0.5364	0.6198	0.7488	0.3869
e_agp*asset	**1**	1	0.0289	0.5202	0.0031	0.9557

Analysis of Maximum Likelihood Estimates

Parameter		DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
e_agp*asset	**2**	1	-0.0756	0.5724	0.0175	0.8949
e_agp*asset	**3**	1	-0.2504	0.5395	0.2154	0.6426
e_agp*SEX		1	0.1263	0.3039	0.1727	0.6777
e_agp*age2	**1**	1	-0.1433	0.5432	0.0696	0.7920
e_agp*age2	**2**	1	0.4483	0.4627	0.9386	0.3326
e_agp*mat_yr		1	0.0195	0.0264	0.5476	0.4593
e_agp*HFA		1	-0.1156	0.3959	0.0852	0.7704
e_agp*brfeed		1	0.4848	0.4291	1.2763	0.2586

```
*Drop e_agp*hfa p=.7704;
Proc surveylogistic data=three;
   Cluster cluster;
   Class asset (REF='4') /param=ref;
   Class age2 (REF='5') /param=ref;
   Model fever24HR (Event='1') = e_agp asset sex age2 mat_yr wfh hfa
brfeed e_agp*asset e_agp*sex e_agp*age2 e_agp*mat_yr e_agp*brfeed;
   Where fever24HR = 0 or fever24HR= 1;
   Contrast "AGP" e_agp 1/est=exp;
run;
```

Model Fit Statistics

Criterion	Intercept Only	Intercept and Covariates
AIC	997.356	973.231
SC	1001.949	1074.278
-2 Log L	995.356	929.231

Testing Global Null Hypothesis: BETA=0

Test	Chi-Square	DF	Pr > ChiSq
Likelihood Ratio	66.1248	21	<.0001
Score	63.5756	21	<.0001
Wald	86.2265	21	<.0001

Type 3 Analysis of Effects

Effect	DF	Wald Chi-Square	Pr > ChiSq
e_agp	1	0.0278	0.8675

Type 3 Analysis of Effects			
Effect	**DF**	**Wald Chi-Square**	**Pr > ChiSq**
asset	4	0.3845	0.9837
SEX	1	0.3966	0.5289
age2	2	3.7424	0.1539
mat_yr	1	1.6597	0.1976
WFH	1	1.3903	0.2384
HFA	1	3.0427	0.0811
brfeed	1	0.0240	0.8769
e_agp*asset	4	1.9090	0.7525
e_agp*SEX	1	0.2199	0.6391
e_agp*age2	2	2.1028	0.3494
e_agp*mat_yr	1	0.5534	0.4569
e_agp*brfeed	1	1.2928	0.2555

Analysis of Maximum Likelihood Estimates						
Parameter		**DF**	**Estimate**	**Standard Error**	**Wald Chi-Square**	**Pr > ChiSq**
Intercept		1	0.1352	0.8845	0.0233	0.8786
e_agp		1	-0.1745	1.0462	0.0278	0.8675
asset	**0**	1	-0.0720	0.4851	0.0220	0.8820
asset	**1**	1	-0.2269	0.4505	0.2538	0.6144
asset	**2**	1	-0.0972	0.4406	0.0486	0.8255
asset	**3**	1	0.0640	0.3641	0.0309	0.8604
SEX		1	-0.1641	0.2605	0.3966	0.5289
age2	**1**	1	0.1895	0.4502	0.1772	0.6738
age2	**2**	1	-0.4475	0.3598	1.5470	0.2136
mat_yr		1	-0.0251	0.0195	1.6597	0.1976
WFH		1	0.4631	0.3928	1.3903	0.2384
HFA		1	0.3034	0.1740	3.0427	0.0811
brfeed		1	-0.0507	0.3274	0.0240	0.8769
e_agp*asset	**0**	1	0.5343	0.6192	0.7444	0.3883
e_agp*asset	**1**	1	0.0175	0.5112	0.0012	0.9727
e_agp*asset	**2**	1	-0.0789	0.5708	0.0191	0.8901

Analysis of Maximum Likelihood Estimates						
Parameter		**DF**	**Estimate**	**Standard Error**	**Wald Chi-Square**	**Pr > ChiSq**
e_agp*asset	**3**	1	-0.2546	0.5389	0.2232	0.6366
e_agp*SEX		1	0.1398	0.2981	0.2199	0.6391
e_agp*age2	**1**	1	-0.1166	0.5412	0.0465	0.8293
e_agp*age2	**2**	1	0.4566	0.4611	0.9803	0.3221
e_agp*mat_yr		1	0.0197	0.0265	0.5534	0.4569
e_agp*brfeed		1	0.4857	0.4272	1.2928	0.2555

```
*Drop e_agp*asset, p=.7525;
Proc surveylogistic data=three;
   Cluster cluster;
   Class asset (REF='4') /param=ref;
   Class age2 (REF='3') /param=ref;
   Model fever24HR (Event='1') = e_agp asset sex age2 mat_yr wfh hfa
brfeed e_agp*sex e_agp*age2 e_agp*mat_yr e_agp*brfeed;
   Where fever24HR = 0 or fever24HR= 1;
   Contrast "AGP" e_agp 1/est=exp;
run;
```

Model Fit Statistics		
Criterion	**Intercept Only**	**Intercept and Covariates**
AIC	997.356	967.145
SC	1001.949	1049.820
-2 Log L	995.356	931.145

Testing Global Null Hypothesis: BETA=0			
Test	**Chi-Square**	**DF**	**Pr > ChiSq**
Likelihood Ratio	64.2108	17	<.0001
Score	61.5662	17	<.0001
Wald	79.0492	17	<.0001

Type 3 Analysis of Effects			
Effect	**DF**	**Wald Chi-Square**	**Pr > ChiSq**
e_agp	1	0.0017	0.9676
asset	4	4.9407	0.2934
SEX	1	0.3209	0.5711

Type 3 Analysis of Effects			
Effect	**DF**	**Wald Chi-Square**	**Pr > ChiSq**
age2	2	3.9578	0.1382
mat_yr	1	1.2717	0.2595
WFH	1	1.5357	0.2153
HFA	1	3.3060	0.0690
brfeed	1	0.0360	0.8495
e_agp*SEX	1	0.1914	0.6618
e_agp*age2	2	2.2398	0.3263
e_agp*mat_yr	1	0.3268	0.5675
e_agp*brfeed	1	1.4090	0.2352

Analysis of Maximum Likelihood Estimates						
Parameter		**DF**	**Estimate**	**Standard Error**	**Wald Chi-Square**	**Pr > ChiSq**
Intercept		1	0.0351	0.8473	0.0017	0.9669
e_agp		1	-0.0372	0.9151	0.0017	0.9676
asset	**0**	1	0.3035	0.2807	1.1689	0.2796
asset	**1**	1	-0.2198	0.2762	0.6333	0.4261
asset	**2**	1	-0.1521	0.2164	0.4940	0.4822
asset	**3**	1	-0.1020	0.2333	0.1911	0.6620
SEX		1	-0.1493	0.2636	0.3209	0.5711
age2	**1**	1	0.2075	0.4581	0.2051	0.6507
age2	**2**	1	-0.4645	0.3670	1.6020	0.2056
mat_yr		1	-0.0222	0.0197	1.2717	0.2595
WFH		1	0.4947	0.3992	1.5357	0.2153
HFA		1	0.3186	0.1752	3.3060	0.0690
brfeed		1	-0.0618	0.3257	0.0360	0.8495
e_agp*SEX		1	0.1304	0.2981	0.1914	0.6618
e_agp*age2	**1**	1	-0.1432	0.5452	0.0690	0.7929
e_agp*age2	**2**	1	0.4684	0.4712	0.9882	0.3202
e_agp*mat_yr		1	0.0151	0.0265	0.3268	0.5675
e_agp*brfeed		1	0.5051	0.4255	1.4090	0.2352

```
*Drop e_agp*sex, p=.6618;
Proc surveylogistic data=three;
   Cluster cluster;
   Class asset (REF='4') /param=ref;
   Class age2 (REF='3') /param=ref;
   Model fever24HR (Event='1') = e_agp asset sex age2 mat_yr wfh hfa
brfeed e_agp*age2 e_agp*mat_yr e_agp*brfeed;
   Where fever24HR = 0 or fever24HR= 1;
   Contrast "AGP" e_agp 1/est=exp;
run;
```

Model Fit Statistics

Criterion	Intercept Only	Intercept and Covariates
AIC	997.356	965.299
SC	1001.949	1043.380
-2 Log L	995.356	931.299

Testing Global Null Hypothesis: BETA=0

Test	Chi-Square	DF	Pr > ChiSq
Likelihood Ratio	64.0577	16	<.0001
Score	61.4865	16	<.0001
Wald	76.1181	16	<.0001

Type 3 Analysis of Effects

Effect	DF	Wald Chi-Square	Pr > ChiSq
e_agp	1	0.0459	0.8304
asset	4	4.9908	0.2882
SEX	1	0.1623	0.6871
age2	2	3.9952	0.1357
mat_yr	1	1.2731	0.2592
WFH	1	1.5152	0.2183
HFA	1	3.4010	0.0652
brfeed	1	0.0340	0.8537
e_agp*age2	2	2.2420	0.3260
e_agp*mat_yr	1	0.3172	0.5733
e_agp*brfeed	1	1.4235	0.2328

Analysis of Maximum Likelihood Estimates

Parameter		DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept		1	-0.1010	0.7283	0.0192	0.8898
e_agp		1	0.1603	0.7481	0.0459	0.8304
asset	**0**	1	0.3140	0.2772	1.2834	0.2573
asset	**1**	1	-0.2151	0.2748	0.6126	0.4338
asset	**2**	1	-0.1453	0.2162	0.4512	0.5018
asset	**3**	1	-0.0935	0.2283	0.1678	0.6820
SEX		1	-0.0639	0.1587	0.1623	0.6871
age2	**1**	1	0.1995	0.4520	0.1948	0.6590
age2	**2**	1	-0.4683	0.3676	1.6231	0.2027
mat_yr		1	-0.0219	0.0194	1.2731	0.2592
WFH		1	0.4941	0.4014	1.5152	0.2183
HFA		1	0.3209	0.1740	3.4010	0.0652
brfeed		1	-0.0602	0.3265	0.0340	0.8537
e_agp*age2	**1**	1	-0.1359	0.5392	0.0636	0.8009
e_agp*age2	**2**	1	0.4750	0.4719	1.0134	0.3141
e_agp*mat_yr		1	0.0148	0.0262	0.3172	0.5733
e_agp*brfeed		1	0.5064	0.4245	1.4235	0.2328

```
*Drop e_agp*mat_yr, p=.5733;
Proc surveylogistic data=three;
   Cluster cluster;
   Class asset (REF='4') /param=ref;
   Class age2 (REF='3') /param=ref;
   Model fever24HR (Event='1') = e_agp asset sex age2 mat_yr wfh hfa
brfeed e_agp*age2 e_agp*brfeed;
   Where fever24HR = 0 or fever24HR= 1;
   Contrast "AGP" e_agp 1/est=exp;
run;
```

Model Fit Statistics

Criterion	Intercept Only	Intercept and Covariates
AIC	997.356	963.734
SC	1001.949	1037.223
-2 Log L	995.356	931.734

Testing Global Null Hypothesis: BETA=0			
Test	**Chi-Square**	**DF**	**Pr > ChiSq**
Likelihood Ratio	63.6222	15	<.0001
Score	61.2748	15	<.0001
Wald	72.0295	15	<.0001

Type 3 Analysis of Effects			
Effect	**DF**	**Wald Chi-Square**	**Pr > ChiSq**
e_agp	1	6.8685	0.0088
asset	4	4.9562	0.2918
SEX	1	0.1608	0.6884
age2	2	3.9034	0.1420
mat_yr	1	1.2151	0.2703
WFH	1	1.4160	0.2341
HFA	1	3.6270	0.0569
brfeed	1	0.0404	0.8407
e_agp*age2	2	2.2210	0.3294
e_agp*brfeed	1	1.4856	0.2229

Analysis of Maximum Likelihood Estimates						
Parameter		**DF**	**Estimate**	**Standard Error**	**Wald Chi-Square**	**Pr > ChiSq**
Intercept		1	-0.3514	0.5472	0.4124	0.5207
e_agp		1	0.5681	0.2168	6.8685	0.0088
asset	**0**	1	0.3064	0.2806	1.1921	0.2749
asset	**1**	1	-0.2224	0.2748	0.6545	0.4185
asset	**2**	1	-0.1520	0.2185	0.4840	0.4866
asset	**3**	1	-0.0975	0.2305	0.1789	0.6723
SEX		1	-0.0633	0.1580	0.1608	0.6884
age2	**1**	1	0.2268	0.4483	0.2559	0.6129
age2	**2**	1	-0.4383	0.3624	1.4633	0.2264
mat_yr		1	-0.0131	0.0119	1.2151	0.2703
WFH		1	0.4839	0.4066	1.4160	0.2341

Analysis of Maximum Likelihood Estimates					
Parameter		**DF**	**Estimate**	**Standard Error**	**Wald Chi-Square**	**Pr > ChiSq**
HFA		1	0.3329	0.1748	3.6270	0.0569
brfeed		1	-0.0644	0.3203	0.0404	0.8407
e_agp*age2	**1**	1	-0.1655	0.5322	0.0967	0.7558
e_agp*age2	**2**	1	0.4485	0.4618	0.9433	0.3314
e_agp*brfeed		1	0.5109	0.4191	1.4856	0.2229

```
*Drop e_agp*brfeed, p=.2229;
Proc surveylogistic data=three;
   Cluster cluster;
   Class asset (REF='4') /param=ref;
   Class age2 (REF='3') /param=ref;
   Model fever24HR (Event='1') = e_agp asset sex age2 mat_yr wfh hfa
brfeed e_agp*age2;
   Where fever24HR = 0 or fever24HR= 1;
   Contrast "AGP" e_agp 1/est=exp;
run;
```

Model Fit Statistics		
Criterion	**Intercept Only**	**Intercept and Covariates**
AIC	997.356	963.279
SC	1001.949	1032.175
-2 Log L	995.356	933.279

Testing Global Null Hypothesis: BETA=0			
Test	**Chi-Square**	**DF**	**Pr > ChiSq**
Likelihood Ratio	62.0772	14	<.0001
Score	59.5864	14	<.0001
Wald	65.9766	14	<.0001

Type 3 Analysis of Effects			
Effect	**DF**	**Wald Chi-Square**	**Pr > ChiSq**
e_agp	1	9.1658	0.0025
asset	4	5.1498	0.2723

Type 3 Analysis of Effects

Effect	DF	Wald Chi-Square	Pr > ChiSq
SEX	1	0.1376	0.7106
age2	2	5.0736	0.0791
mat_yr	1	1.2709	0.2596
WFH	1	1.3934	0.2378
HFA	1	3.4034	0.0651
brfeed	1	1.9375	0.1639
e_agp*age2	2	4.1366	0.1264

Analysis of Maximum Likelihood Estimates

Parameter		DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept		1	-0.4149	0.5589	0.5512	0.4578
e_agp		1	0.6810	0.2249	9.1658	0.0025
asset	**0**	1	0.2972	0.2774	1.1477	0.2840
asset	**1**	1	-0.2251	0.2714	0.6882	0.4068
asset	**2**	1	-0.1659	0.2133	0.6052	0.4366
asset	**3**	1	-0.1080	0.2236	0.2332	0.6291
SEX		1	-0.0587	0.1583	0.1376	0.7106
age2	**1**	1	-0.0256	0.4194	0.0037	0.9514
age2	**2**	1	-0.6124	0.3104	3.8926	0.0485
mat_yr		1	-0.0134	0.0119	1.2709	0.2596
WFH		1	0.4882	0.4136	1.3934	0.2378
HFA		1	0.3238	0.1755	3.4034	0.0651
brfeed		1	0.2735	0.1965	1.9375	0.1639
e_agp*age2	**1**	1	0.2117	0.4108	0.2657	0.6063
e_agp*age2	**2**	1	0.7025	0.3457	4.1290	0.0422

```
*Model without interaction terms;
Proc surveylogistic data=three;
   Cluster cluster;
   Class asset (REF='4') /param=ref;
   Class age2 (REF='3') /param=ref;
   Model fever24HR (Event='1') = e_agp asset sex age2 mat_yr wfh hfa
brfeed;
   Where fever24HR = 0 or fever24HR= 1;
```

```
   Contrast "AGP" e_agp 1/est=exp;
run;
```

Model Fit Statistics		
Criterion	**Intercept Only**	**Intercept and Covariates**
AIC	997.356	963.067
SC	1001.949	1022.776
-2 Log L	995.356	937.067

Testing Global Null Hypothesis: BETA=0			
Test	**Chi-Square**	**DF**	**Pr > ChiSq**
Likelihood Ratio	58.2896	12	<.0001
Score	56.4457	12	<.0001
Wald	68.5959	12	<.0001

Type 3 Analysis of Effects			
Effect	**DF**	**Wald Chi-Square**	**Pr > ChiSq**
e_agp	1	33.7495	<.0001
asset	4	5.0503	0.2822
SEX	1	0.1226	0.7263
age2	2	1.6435	0.4397
mat_yr	1	0.9866	0.3206
WFH	1	1.7228	0.1893
HFA	1	2.9444	0.0862
brfeed	1	1.8576	0.1729

Analysis of Maximum Likelihood Estimates						
Parameter		**DF**	**Estimate**	**Standard Error**	**Wald Chi-Square**	**Pr > ChiSq**
Intercept		1	-0.6841	0.5107	1.7945	0.1804
e_agp		1	0.9978	0.1717	33.7495	<.0001
asset	**0**	1	0.2971	0.2713	1.1989	0.2735
asset	**1**	1	-0.2179	0.2640	0.6812	0.4092

Analysis of Maximum Likelihood Estimates						
Parameter		**DF**	**Estimate**	**Standard Error**	**Wald Chi-Square**	**Pr > ChiSq**
asset	**2**	1	-0.1550	0.2115	0.5372	0.4636
asset	**3**	1	-0.0884	0.2248	0.1545	0.6943
SEX		1	-0.0547	0.1562	0.1226	0.7263
age2	**1**	1	0.1172	0.3164	0.1371	0.7112
age2	**2**	1	-0.1501	0.2056	0.5329	0.4654
mat_yr		1	-0.0113	0.0114	0.9866	0.3206
WFH		1	0.5353	0.4078	1.7228	0.1893
HFA		1	0.2982	0.1738	2.9444	0.0862
brfeed		1	0.2648	0.1943	1.8576	0.1729

Odds Ratio Estimates			
Effect	**Point Estimate**	**95% Wald Confidence Limits**	
e_agp	2.712	1.937	3.798
asset 0 vs 4	1.346	0.791	2.291
asset 1 vs 4	0.804	0.479	1.349
asset 2 vs 4	0.856	0.566	1.296
asset 3 vs 4	0.915	0.589	1.422
SEX	0.947	0.697	1.286
age2 1 vs 3	1.124	0.605	2.090
age2 2 vs 3	0.861	0.575	1.288
mat_yr	0.989	0.967	1.011
WFH	1.708	0.768	3.799
HFA	1.347	0.958	1.894
brfeed	1.303	0.890	1.907

Association of Predicted Probabilities and Observed Responses			
Percent Concordant	65.9	**Somers' D**	0.321
Percent Discordant	33.7	**Gamma**	0.323
Percent Tied	0.4	**Tau-a**	0.157
Pairs	130200	**c**	0.661

Contrast Test Results			
Contrast	**DF**	**Wald Chi-Square**	**Pr > ChiSq**
AGP	1	33.7495	<.0001

Contrast Estimation and Testing Results by Row								
Contrast	**Type**	**Row**	**Estimate**	**Standard Error**	**Alpha**	**Confidence Limits**		**Wald Chi-Square**	**Pr > ChiSq**
AGP	**EXP**	**1**	2.7122	0.4658	0.05	1.9370	3.7976	33.7495	<.0001

```
*Drop all covariates;
**********************Final Model*************************;
Proc surveylogistic data=three;
   Cluster cluster;
   Model fever24HR (Event='1') = e_agp;
   Where fever24HR = 0 or fever24HR= 1;
   Contrast "AGP" e_agp 1/est=exp;

run;
```

Model Fit Statistics		
Criterion	**Intercept Only**	**Intercept and Covariates**
AIC	1114.595	1075.244
SC	1119.301	1084.658
-2 Log L	1112.595	1071.244

Testing Global Null Hypothesis: BETA=0			
Test	**Chi-Square**	**DF**	**Pr > ChiSq**
Likelihood Ratio	41.3504	1	<.0001
Score	40.4173	1	<.0001
Wald	36.8585	1	<.0001

Analysis of Maximum Likelihood Estimates					
Parameter	**DF**	**Estimate**	**Standard Error**	**Wald Chi-Square**	**Pr > ChiSq**
Intercept	1	-0.9339	0.1157	65.1914	<.0001
e_agp	1	0.9620	0.1585	36.8585	<.0001

Odds Ratio Estimates			
Effect	**Point Estimate**	**95% Wald Confidence Limits**	
e_agp	2.617	1.918	3.570

Association of Predicted Probabilities and Observed Responses			
Percent Concordant	35.6	**Somers' D**	0.220
Percent Discordant	13.6	**Gamma**	0.447
Percent Tied	50.9	**Tau-a**	0.107
Pairs	162925	**c**	0.610

Contrast Test Results			
Contrast	**DF**	**Wald Chi-Square**	**Pr > ChiSq**
AGP	1	36.8585	<.0001

Contrast Estimation and Testing Results by Row									
Contrast	**Type**	**Row**	**Estimate**	**Standard Error**	**Alpha**	**Confidence Limits**		**Wald Chi-Square**	**Pr > ChiSq**
AGP	**EXP**	**1**	2.6168	0.4146	0.05	1.9183	3.5699	36.8585	<.0001

Exposure: Elevated CRP Outcome: Fever

```
*Full model with interaction terms;

Proc surveylogistic data=three;
   Cluster cluster;
   Class asset (REF='4') /param=ref;
   Class age2 (REF='3') /param=ref;
   Model fever24HR (Event='1') = e_crp asset sex age2 mat_yr wfh hfa
brfeed e_crp*asset e_crp*sex e_crp*age2 e_crp*mat_yr e_crp*wfh
e_crp*hfa e_crp*brfeed;
   Where fever24HR = 0 or fever24HR= 1;
   Contrast "CRP" e_crp 1/est=exp;
run;
```

Model Fit Statistics		
Criterion	**Intercept Only**	**Intercept and Covariates**
AIC	997.356	925.828

Model Fit Statistics		
Criterion	**Intercept Only**	**Intercept and Covariates**
SC	1001.949	1036.061
-2 Log L	995.356	877.828

Testing Global Null Hypothesis: BETA=0			
Test	**Chi-Square**	**DF**	**Pr > ChiSq**
Likelihood Ratio	117.5281	23	<.0001
Score	111.9923	23	<.0001
Wald	200.2472	23	<.0001

Type 3 Analysis of Effects			
Effect	**DF**	**Wald Chi-Square**	**Pr > ChiSq**
e_crp	1	2.2531	0.1334
asset	4	4.8422	0.3039
SEX	1	0.0000	0.9961
age2	2	8.9261	0.0115
mat_yr	1	2.4319	0.1189
WFH	1	0.0743	0.7852
HFA	1	7.7005	0.0055
brfeed	1	0.0062	0.9375
e_crp*asset	4	6.2217	0.1832
e_crp*SEX	1	0.5848	0.4444
e_crp*age2	2	6.8278	0.0329
e_crp*mat_yr	1	0.7455	0.3879
e_crp*WFH	1	0.4207	0.5166
e_crp*HFA	1	2.6285	0.1050
e_crp*brfeed	1	1.4679	0.2257

Analysis of Maximum Likelihood Estimates					
Parameter	**DF**	**Estimate**	**Standard Error**	**Wald Chi-Square**	**Pr > ChiSq**
Intercept	1	-0.3619	0.6642	0.2969	0.5858

Analysis of Maximum Likelihood Estimates

Parameter		DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
e_crp		1	1.6437	1.0951	2.2531	0.1334
asset	**0**	1	0.5667	0.3300	2.9501	0.0859
asset	**1**	1	-0.0923	0.3663	0.0635	0.8011
asset	**2**	1	0.1979	0.3227	0.3760	0.5397
asset	**3**	1	0.0890	0.2706	0.1081	0.7423
SEX		1	0.00102	0.2093	0.0000	0.9961
age2	**1**	1	0.3169	0.3463	0.8375	0.3601
age2	**2**	1	-0.5011	0.2609	3.6887	0.0548
mat_yr		1	-0.0237	0.0152	2.4319	0.1189
WFH		1	0.1825	0.6697	0.0743	0.7852
HFA		1	0.6359	0.2292	7.7005	0.0055
brfeed		1	0.0199	0.2534	0.0062	0.9375
e_crp*asset	**0**	1	-0.6711	0.6768	0.9831	0.3214
e_crp*asset	**1**	1	-0.4983	0.5804	0.7373	0.3905
e_crp*asset	**2**	1	-1.3216	0.5808	5.1784	0.0229
e_crp*asset	**3**	1	-0.8847	0.5646	2.4552	0.1171
e_crp*SEX		1	-0.2624	0.3432	0.5848	0.4444
e_crp*age2	**1**	1	-0.3604	0.5460	0.4357	0.5092
e_crp*age2	**2**	1	0.8527	0.4645	3.3703	0.0664
e_crp*mat_yr		1	0.0204	0.0236	0.7455	0.3879
e_crp*WFH		1	0.6116	0.9429	0.4207	0.5166
e_crp*HFA		1	-0.7444	0.4591	2.6285	0.1050
e_crp*brfeed		1	0.5186	0.4281	1.4679	0.2257

Association of Predicted Probabilities and Observed Responses

Percent Concordant	72.1	**Somers' D**	0.446
Percent Discordant	27.5	**Gamma**	0.447
Percent Tied	0.3	**Tau-a**	0.218
Pairs	130200	**c**	0.723

Contrast Test Results

Contrast	DF	Wald Chi-Square	Pr > ChiSq
CRP	1	2.2531	0.1334

Contrast Estimation and Testing Results by Row

Contrast	Type	Row	Estimate	Standard Error	Alpha	Confidence Limits		Wald Chi-Square	Pr > ChiSq
CRP	EXP	1	5.1745	5.6665	0.05	0.6050	44.2598	2.2531	0.1334

```
*Drop e_crp*wfh, p=.5166;
Proc surveylogistic data=three;
   Cluster cluster;
   Class asset (REF='4') /param=ref;
   Class age2 (REF='3') /param=ref;
   Model fever24HR (Event='1') = e_crp asset sex age2 mat_yr wfh hfa
brfeed e_crp*asset e_crp*sex e_crp*age2 e_crp*mat_yr e_crp*hfa
e_crp*brfeed;
   Where fever24HR = 0 or fever24HR= 1;
   Contrast "CRP" e_crp 1/est=exp;
run;
```

Model Fit Statistics

Criterion	Intercept Only	Intercept and Covariates
AIC	997.356	924.226
SC	1001.949	1029.866
-2 Log L	995.356	878.226

Testing Global Null Hypothesis: BETA=0

Test	Chi-Square	DF	Pr > ChiSq
Likelihood Ratio	117.1302	22	<.0001
Score	111.7971	22	<.0001
Wald	177.5347	22	<.0001

Type 3 Analysis of Effects

Effect	DF	Wald Chi-Square	Pr > ChiSq
e_crp	1	2.1876	0.1391
asset	4	4.7270	0.3165
SEX	1	0.0003	0.9870

Type 3 Analysis of Effects			
Effect	**DF**	**Wald Chi-Square**	**Pr > ChiSq**
age2	2	9.1699	0.0102
mat_yr	1	2.3808	0.1228
WFH	1	1.2579	0.2621
HFA	1	7.5729	0.0059
brfeed	1	0.0058	0.9391
e_crp*asset	4	6.0678	0.1941
e_crp*SEX	1	0.5704	0.4501
e_crp*age2	2	6.6990	0.0351
e_crp*mat_yr	1	0.7562	0.3845
e_crp*HFA	1	2.5531	0.1101
e_crp*brfeed	1	1.4914	0.2220

Analysis of Maximum Likelihood Estimates						
Parameter		**DF**	**Estimate**	**Standard Error**	**Wald Chi-Square**	**Pr > ChiSq**
Intercept		1	-0.3598	0.6639	0.2937	0.5878
e_crp		1	1.6181	1.0940	2.1876	0.1391
asset	**0**	1	0.5569	0.3293	2.8607	0.0908
asset	**1**	1	-0.0969	0.3654	0.0703	0.7909
asset	**2**	1	0.1891	0.3219	0.3451	0.5569
asset	**3**	1	0.0801	0.2692	0.0886	0.7660
SEX		1	-0.00343	0.2098	0.0003	0.9870
age2	**1**	1	0.3140	0.3462	0.8226	0.3644
age2	**2**	1	-0.5051	0.2594	3.7918	0.0515
mat_yr		1	-0.0234	0.0152	2.3808	0.1228
WFH		1	0.4840	0.4316	1.2579	0.2621
HFA		1	0.6309	0.2292	7.5729	0.0059
brfeed		1	0.0193	0.2527	0.0058	0.9391
e_crp*asset	**0**	1	-0.6400	0.6734	0.9032	0.3419
e_crp*asset	**1**	1	-0.4923	0.5812	0.7176	0.3969
e_crp*asset	**2**	1	-1.2851	0.5738	5.0152	0.0251
e_crp*asset	**3**	1	-0.8807	0.5630	2.4468	0.1178

Analysis of Maximum Likelihood Estimates

Parameter		DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
e_crp*SEX		1	-0.2579	0.3415	0.5704	0.4501
e_crp*age2	**1**	1	-0.3305	0.5377	0.3777	0.5389
e_crp*age2	**2**	1	0.8650	0.4587	3.5557	0.0593
e_crp*mat_yr		1	0.0206	0.0237	0.7562	0.3845
e_crp*HFA		1	-0.7277	0.4554	2.5531	0.1101
e_crp*brfeed		1	0.5241	0.4292	1.4914	0.2220

```
*Drop e_crp*sex, p=.4501;
Proc surveylogistic data=three;
   Cluster cluster;
   Class asset (REF='4') /param=ref;
   Class age2 (REF='3') /param=ref;
   Model fever24HR (Event='1') = e_crp asset sex age2 mat_yr wfh hfa
brfeed e_crp*asset e_crp*age2 e_crp*mat_yr e_crp*hfa e_crp*brfeed;
   Where fever24HR = 0 or fever24HR= 1;
   Contrast "CRP" e_crp 1/est=exp;
run;
```

Model Fit Statistics

Criterion	Intercept Only	Intercept and Covariates
AIC	997.356	922.775
SC	1001.949	1023.822
-2 Log L	995.356	878.775

Testing Global Null Hypothesis: BETA=0

Test	Chi-Square	DF	Pr > ChiSq
Likelihood Ratio	116.5816	21	<.0001
Score	111.2469	21	<.0001
Wald	178.1151	21	<.0001

Type 3 Analysis of Effects

Effect	DF	Wald Chi-Square	Pr > ChiSq
e_crp	1	1.7372	0.1875
asset	4	4.7659	0.3122

Type 3 Analysis of Effects			
Effect	**DF**	**Wald Chi-Square**	**Pr > ChiSq**
SEX	1	0.3546	0.5515
age2	2	9.0254	0.0110
mat_yr	1	2.5088	0.1132
WFH	1	1.3369	0.2476
HFA	1	7.4697	0.0063
brfeed	1	0.0066	0.9355
e_crp*asset	4	6.1682	0.1869
e_crp*age2	2	6.6007	0.0369
e_crp*mat_yr	1	0.7732	0.3792
e_crp*HFA	1	2.3334	0.1266
e_crp*brfeed	1	1.4736	0.2248

Analysis of Maximum Likelihood Estimates						
Parameter		**DF**	**Estimate**	**Standard Error**	**Wald Chi-Square**	**Pr > ChiSq**
Intercept		1	-0.2139	0.5822	0.1350	0.7133
e_crp		1	1.2173	0.9236	1.7372	0.1875
asset	**0**	1	0.5617	0.3299	2.8992	0.0886
asset	**1**	1	-0.0983	0.3660	0.0721	0.7882
asset	**2**	1	0.1854	0.3207	0.3341	0.5633
asset	**3**	1	0.0757	0.2700	0.0787	0.7791
SEX		1	-0.0938	0.1576	0.3546	0.5515
age2	**1**	1	0.3139	0.3467	0.8195	0.3653
age2	**2**	1	-0.5018	0.2588	3.7605	0.0525
mat_yr		1	-0.0238	0.0151	2.5088	0.1132
WFH		1	0.4916	0.4252	1.3369	0.2476
HFA		1	0.6202	0.2269	7.4697	0.0063
brfeed		1	0.0204	0.2522	0.0066	0.9355
e_crp*asset	**0**	1	-0.6447	0.6757	0.9102	0.3401
e_crp*asset	**1**	1	-0.5071	0.5872	0.7458	0.3878
e_crp*asset	**2**	1	-1.2858	0.5707	5.0761	0.0243
e_crp*asset	**3**	1	-0.8996	0.5632	2.5516	0.1102

Analysis of Maximum Likelihood Estimates						
Parameter		**DF**	**Estimate**	**Standard Error**	**Wald Chi-Square**	**Pr > ChiSq**
e_crp*age2	**1**	1	-0.3321	0.5352	0.3852	0.5348
e_crp*age2	**2**	1	0.8557	0.4554	3.5307	0.0602
e_crp*mat_yr		1	0.0210	0.0238	0.7732	0.3792
e_crp*HFA		1	-0.6881	0.4505	2.3334	0.1266
e_crp*brfeed		1	0.5218	0.4298	1.4736	0.2248

```
*Drop e_crp*mat_yr, p=.3792;
Proc surveylogistic data=three;
   Cluster cluster;
   Class asset (REF='4') /param=ref;
   Class age2 (REF='3') /param=ref;
   Model fever24HR (Event='1') = e_crp asset sex age2 mat_yr wfh hfa
brfeed e_crp*asset e_crp*age2 e_crp*hfa e_crp*brfeed;
   Where fever24HR = 0 or fever24HR= 1;
   Contrast "CRP" e_crp 1/est=exp;
run;
```

Model Fit Statistics		
Criterion	**Intercept Only**	**Intercept and Covariates**
AIC	997.356	921.508
SC	1001.949	1017.962
-2 Log L	995.356	879.508

Testing Global Null Hypothesis: BETA=0			
Test	**Chi-Square**	**DF**	**Pr > ChiSq**
Likelihood Ratio	115.8486	20	<.0001
Score	110.7341	20	<.0001
Wald	178.0049	20	<.0001

Type 3 Analysis of Effects			
Effect	**DF**	**Wald Chi-Square**	**Pr > ChiSq**
e_crp	1	13.7090	0.0002
asset	4	5.2942	0.2584
SEX	1	0.3258	0.5682

Type 3 Analysis of Effects			
Effect	**DF**	**Wald Chi-Square**	**Pr > ChiSq**
age2	2	8.9968	0.0111
mat_yr	1	2.2325	0.1351
WFH	1	1.5376	0.2150
HFA	1	7.4129	0.0065
brfeed	1	0.0036	0.9520
e_crp*asset	4	6.9582	0.1381
e_crp*age2	2	6.7163	0.0348
e_crp*HFA	1	2.2525	0.1334
e_crp*brfeed	1	1.4807	0.2237

Analysis of Maximum Likelihood Estimates						
Parameter		**DF**	**Estimate**	**Standard Error**	**Wald Chi-Square**	**Pr > ChiSq**
Intercept		1	-0.4235	0.4908	0.7447	0.3881
e_crp		1	1.8570	0.5015	13.7090	0.0002
asset	**0**	1	0.5860	0.3205	3.3428	0.0675
asset	**1**	1	-0.0889	0.3645	0.0595	0.8073
asset	**2**	1	0.1857	0.3202	0.3364	0.5619
asset	**3**	1	0.0787	0.2677	0.0864	0.7688
SEX		1	-0.0892	0.1562	0.3258	0.5682
age2	**1**	1	0.3234	0.3433	0.8874	0.3462
age2	**2**	1	-0.4883	0.2554	3.6567	0.0558
mat_yr		1	-0.0166	0.0111	2.2325	0.1351
WFH		1	0.5147	0.4151	1.5376	0.2150
HFA		1	0.6185	0.2272	7.4129	0.0065
brfeed		1	0.0149	0.2484	0.0036	0.9520
e_crp*asset	**0**	1	-0.7721	0.6423	1.4449	0.2293
e_crp*asset	**1**	1	-0.5935	0.5678	1.0924	0.2959
e_crp*asset	**2**	1	-1.3753	0.5515	6.2177	0.0126
e_crp*asset	**3**	1	-0.9443	0.5652	2.7912	0.0948
e_crp*age2	**1**	1	-0.3758	0.5326	0.4978	0.4805
e_crp*age2	**2**	1	0.8430	0.4509	3.4952	0.0615

Analysis of Maximum Likelihood Estimates					
Parameter	**DF**	**Estimate**	**Standard Error**	**Wald Chi-Square**	**Pr > ChiSq**
e_crp*HFA	1	-0.6821	0.4545	2.2525	0.1334
e_crp*brfeed	1	0.5191	0.4266	1.4807	0.2237

```
*Drop e_crp*brfeed, p=.2237;
Proc surveylogistic data=three;
   Cluster cluster;
   Class asset (REF='4') /param=ref;
   Class age2 (REF='3') /param=ref;
   Model fever24HR (Event='1') = e_crp asset sex age2 mat_yr wfh hfa
brfeed e_crp*asset e_crp*age2 e_crp*hfa;
   Where fever24HR = 0 or fever24HR= 1;
   Contrast "CRP" e_crp 1/est=exp;
run;
```

Model Fit Statistics		
Criterion	**Intercept Only**	**Intercept and Covariates**
AIC	997.356	921.028
SC	1001.949	1012.889
-2 Log L	995.356	881.028

Testing Global Null Hypothesis: BETA=0			
Test	**Chi-Square**	**DF**	**Pr > ChiSq**
Likelihood Ratio	114.3285	19	<.0001
Score	109.3318	19	<.0001
Wald	180.4699	19	<.0001

Type 3 Analysis of Effects			
Effect	**DF**	**Wald Chi-Square**	**Pr > ChiSq**
e_crp	1	16.2087	<.0001
asset	4	5.4556	0.2437
SEX	1	0.3334	0.5637
age2	2	9.5669	0.0084
mat_yr	1	2.3837	0.1226
WFH	1	1.5993	0.2060

Type 3 Analysis of Effects

Effect	DF	Wald Chi-Square	Pr > ChiSq
HFA	1	7.3774	0.0066
brfeed	1	1.0713	0.3007
e_crp*asset	4	7.3431	0.1188
e_crp*age2	2	7.8429	0.0198
e_crp*HFA	1	2.6301	0.1049

Analysis of Maximum Likelihood Estimates

Parameter		DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept		1	-0.4426	0.4949	0.7999	0.3711
e_crp		1	1.9692	0.4891	16.2087	<.0001
asset	**0**	1	0.5785	0.3211	3.2462	0.0716
asset	**1**	1	-0.1087	0.3636	0.0894	0.7650
asset	**2**	1	0.1768	0.3196	0.3061	0.5801
asset	**3**	1	0.0872	0.2672	0.1064	0.7443
SEX		1	-0.0906	0.1569	0.3334	0.5637
age2	**1**	1	0.1685	0.3522	0.2289	0.6324
age2	**2**	1	-0.5889	0.2505	5.5269	0.0187
mat_yr		1	-0.0171	0.0111	2.3837	0.1226
WFH		1	0.5268	0.4166	1.5993	0.2060
HFA		1	0.6179	0.2275	7.3774	0.0066
brfeed		1	0.2144	0.2071	1.0713	0.3007
e_crp*asset	**0**	1	-0.7624	0.6361	1.4363	0.2307
e_crp*asset	**1**	1	-0.5253	0.5667	0.8590	0.3540
e_crp*asset	**2**	1	-1.3689	0.5527	6.1342	0.0133
e_crp*asset	**3**	1	-0.9672	0.5586	2.9984	0.0833
e_crp*age2	**1**	1	-0.0145	0.4947	0.0009	0.9766
e_crp*age2	**2**	1	1.0823	0.4214	6.5970	0.0102
e_crp*HFA		1	-0.7151	0.4410	2.6301	0.1049

```
*Drop e_crp*asset, p=.1188;
Proc surveylogistic data=three;
   Cluster cluster;
```

```
   Class asset (REF='4') /param=ref;
   Class age2 (REF='3') /param=ref;
   Model fever24HR (Event='1') = e_crp asset sex age2 mat_yr wfh hfa
brfeed e_crp*hfa e_crp*age2;
   Where fever24HR = 0 or fever24HR= 1;
   Contrast "CRP" e_crp 1/est=exp;
run;
```

Model Fit Statistics

Criterion	Intercept Only	Intercept and Covariates
AIC	997.356	920.075
SC	1001.949	993.563
-2 Log L	995.356	888.075

Testing Global Null Hypothesis: BETA=0

Test	Chi-Square	DF	Pr > ChiSq
Likelihood Ratio	107.2817	15	<.0001
Score	102.9029	15	<.0001
Wald	150.4829	15	<.0001

Type 3 Analysis of Effects

Effect	DF	Wald Chi-Square	Pr > ChiSq
e_crp	1	13.2484	0.0003
asset	4	8.2406	0.0832
SEX	1	0.4147	0.5196
age2	2	10.1987	0.0061
mat_yr	1	1.5435	0.2141
WFH	1	1.2735	0.2591
HFA	1	7.7471	0.0054
brfeed	1	1.3078	0.2528
e_crp*HFA	1	2.2177	0.1364
e_crp*age2	2	7.9130	0.0191

Analysis of Maximum Likelihood Estimates

Parameter	DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq

Analysis of Maximum Likelihood Estimates

Parameter		DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept		1	-0.2967	0.4837	0.3762	0.5397
e_crp		1	1.1455	0.3147	13.2484	0.0003
asset	**0**	1	0.3789	0.2872	1.7401	0.1871
asset	**1**	1	-0.2223	0.2765	0.6463	0.4214
asset	**2**	1	-0.2613	0.2479	1.1113	0.2918
asset	**3**	1	-0.2026	0.2238	0.8198	0.3652
SEX		1	-0.0975	0.1514	0.4147	0.5196
age2	**1**	1	0.1404	0.3523	0.1590	0.6901
age2	**2**	1	-0.6233	0.2491	6.2599	0.0124
mat_yr		1	-0.0138	0.0111	1.5435	0.2141
WFH		1	0.4782	0.4238	1.2735	0.2591
HFA		1	0.6312	0.2268	7.7471	0.0054
brfeed		1	0.2330	0.2038	1.3078	0.2528
e_crp*HFA		1	-0.6324	0.4246	2.2177	0.1364
e_crp*age2	**1**	1	0.0145	0.4981	0.0008	0.9768
e_crp*age2	**2**	1	1.0879	0.4148	6.8800	0.0087

```
*Drop e_crp*hfa, p=.1364;
Proc surveylogistic data=three;
   Cluster cluster;
   Class asset (REF='4') /param=ref;
   Class age2 (REF='3') /param=ref;
   Model fever24HR (Event='1') = e_crp asset sex age2 mat_yr wfh hfa
brfeed e_crp*age2;
   Where fever24HR = 0 or fever24HR= 1;
   Contrast "CRP" e_crp 1/est=exp;
run;
```

Model Fit Statistics

Criterion	Intercept Only	Intercept and Covariates
AIC	997.356	920.597
SC	1001.949	989.493
-2 Log L	995.356	890.597

Testing Global Null Hypothesis: BETA=0			
Test	**Chi-Square**	**DF**	**Pr > ChiSq**
Likelihood Ratio	104.7593	14	<.0001
Score	100.7485	14	<.0001
Wald	143.8881	14	<.0001

Type 3 Analysis of Effects			
Effect	**DF**	**Wald Chi-Square**	**Pr > ChiSq**
e_crp	1	11.1176	0.0009
asset	4	8.0910	0.0883
SEX	1	0.3558	0.5509
age2	2	9.9098	0.0070
mat_yr	1	1.5167	0.2181
WFH	1	1.1398	0.2857
HFA	1	4.8859	0.0271
brfeed	1	1.5040	0.2201
e_crp*age2	2	8.6758	0.0131

Analysis of Maximum Likelihood Estimates						
Parameter		**DF**	**Estimate**	**Standard Error**	**Wald Chi-Square**	**Pr > ChiSq**
Intercept		1	-0.2467	0.4895	0.2540	0.6143
e_crp		1	0.9028	0.2708	11.1176	0.0009
asset	**0**	1	0.3931	0.2854	1.8977	0.1683
asset	**1**	1	-0.2272	0.2743	0.6861	0.4075
asset	**2**	1	-0.2317	0.2450	0.8943	0.3443
asset	**3**	1	-0.1787	0.2264	0.6235	0.4298
SEX		1	-0.0913	0.1530	0.3558	0.5509
age2	**1**	1	0.0756	0.3472	0.0474	0.8277
age2	**2**	1	-0.6373	0.2477	6.6199	0.0101
mat_yr		1	-0.0140	0.0114	1.5167	0.2181
WFH		1	0.4607	0.4316	1.1398	0.2857
HFA		1	0.4230	0.1914	4.8859	0.0271
brfeed		1	0.2513	0.2049	1.5040	0.2201

Analysis of Maximum Likelihood Estimates

Parameter		DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
e_crp*age2	**1**	1	0.2038	0.4667	0.1908	0.6623
e_crp*age2	**2**	1	1.1979	0.4133	8.3995	0.0038

```
Proc surveylogistic data=three;
   Cluster cluster;
   Class asset (REF='4') /param=ref;
   Class age2 (REF='3') /param=ref;
   Model fever24HR (Event='1') = e_crp asset sex age2 mat_yr wfh hfa
brfeed e_crp*age2;
   Where fever24HR = 0 or fever24HR= 1;
   Contrast "24-35 Month" e_crp 1 age2 0 0 e_crp*age2 0 0/est=exp;
   Contrast "6-12 Month" e_crp 1 age2 1 0 e_crp*age2 1 0/est=exp;
   Contrast "12-24 Month" e_crp 1 age2 0 1 e_crp*age2 0 1/est=exp;
run;
```

Model Fit Statistics

Criterion	Intercept Only	Intercept and Covariates
AIC	997.356	920.597
SC	1001.949	989.493
-2 Log L	995.356	890.597

Testing Global Null Hypothesis: BETA=0

Test	Chi-Square	DF	Pr > ChiSq
Likelihood Ratio	104.7593	14	<.0001
Score	100.7485	14	<.0001
Wald	143.8881	14	<.0001

Type 3 Analysis of Effects

Effect	DF	Wald Chi-Square	Pr > ChiSq
e_crp	1	11.1176	0.0009
asset	4	8.0910	0.0883
SEX	1	0.3558	0.5509
age2	2	9.9098	0.0070
mat_yr	1	1.5167	0.2181

Type 3 Analysis of Effects

Effect	DF	Wald Chi-Square	Pr > ChiSq
WFH	1	1.1398	0.2857
HFA	1	4.8859	0.0271
brfeed	1	1.5040	0.2201
e_crp*age2	2	8.6758	0.0131

Analysis of Maximum Likelihood Estimates

Parameter		DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept		1	-0.2467	0.4895	0.2540	0.6143
e_crp		1	0.9028	0.2708	11.1176	0.0009
asset	**0**	1	0.3931	0.2854	1.8977	0.1683
asset	**1**	1	-0.2272	0.2743	0.6861	0.4075
asset	**2**	1	-0.2317	0.2450	0.8943	0.3443
asset	**3**	1	-0.1787	0.2264	0.6235	0.4298
SEX		1	-0.0913	0.1530	0.3558	0.5509
age2	**1**	1	0.0756	0.3472	0.0474	0.8277
age2	**2**	1	-0.6373	0.2477	6.6199	0.0101
mat_yr		1	-0.0140	0.0114	1.5167	0.2181
WFH		1	0.4607	0.4316	1.1398	0.2857
HFA		1	0.4230	0.1914	4.8859	0.0271
brfeed		1	0.2513	0.2049	1.5040	0.2201
e_crp*age2	**1**	1	0.2038	0.4667	0.1908	0.6623
e_crp*age2	**2**	1	1.1979	0.4133	8.3995	0.0038

Odds Ratio Estimates

Effect	Point Estimate	95% Wald Confidence Limits	
asset 0 vs 4	1.482	0.847	2.592
asset 1 vs 4	0.797	0.465	1.364
asset 2 vs 4	0.793	0.491	1.282
asset 3 vs 4	0.836	0.537	1.303
SEX	0.913	0.676	1.232

Odds Ratio Estimates

Effect	Point Estimate	95% Wald Confidence Limits	
mat_yr	0.986	0.964	1.008
WFH	1.585	0.680	3.694
HFA	1.527	1.049	2.221
brfeed	1.286	0.860	1.921

Association of Predicted Probabilities and Observed Responses

Percent Concordant	71.2	**Somers' D**	0.428
Percent Discordant	28.5	**Gamma**	0.429
Percent Tied	0.3	**Tau-a**	0.209
Pairs	130200	**c**	0.714

Contrast Test Results

Contrast	DF	Wald Chi-Square	Pr > ChiSq
24-35 Month	1	11.1176	0.0009
6-12 Month	1	6.6554	0.0099
12-24 Month	1	30.9299	<.0001

Contrast Estimation and Testing Results by Row

Contrast	Type	Row	Estimate	Standard Error	Alpha	Confidence Limits		Wald Chi-Square	Pr > ChiSq
24-35 Month	**EXP**	**1**	2.4664	0.6678	0.05	1.4508	4.1931	11.1176	0.0009
6-12 Month	**EXP**	**1**	3.2615	1.4946	0.05	1.3285	8.0072	6.6554	0.0099
12-24 Month	**EXP**	**1**	4.3206	1.1369	0.05	2.5797	7.2365	30.9299	<.0001

```
*Drop all covariates except age2 and e_crp*age2, and brfeed, hfa;
Proc surveylogistic data=three;
   Cluster cluster;
   Class asset (REF='4') /param=ref;
   Class age2 (REF='3') /param=ref;
   Model fever24HR (Event='1') = e_crp age2 e_crp*age2 brfeed hfa;
   Where fever24HR = 0 or fever24HR= 1;
   Contrast "24-35 Month" e_crp 1 age2 0 0 e_crp*age2 0 0/est=exp;
   Contrast "6-12 Month" e_crp 1 age2 1 0 e_crp*age2 1 0/est=exp;
```

```
   Contrast "12-24 Month" e_crp 1 age2 0 1 e_crp*age2 0 1/est=exp;
run;
```

Model Fit Statistics		
Criterion	**Intercept Only**	**Intercept and Covariates**
AIC	1021.630	933.717
SC	1026.244	970.635
-2 Log L	1019.630	917.717

Testing Global Null Hypothesis: BETA=0			
Test	**Chi-Square**	**DF**	**Pr > ChiSq**
Likelihood Ratio	101.9126	7	<.0001
Score	98.9777	7	<.0001
Wald	117.7283	7	<.0001

Type 3 Analysis of Effects			
Effect	**DF**	**Wald Chi-Square**	**Pr > ChiSq**
e_crp	1	12.0684	0.0005
age2	2	12.0301	0.0024
e_crp*age2	2	9.2470	0.0098
brfeed	1	1.8430	0.1746
HFA	1	5.9910	0.0144

Analysis of Maximum Likelihood Estimates						
Parameter		**DF**	**Estimate**	**Standard Error**	**Wald Chi-Square**	**Pr > ChiSq**
Intercept		1	-0.8648	0.1374	39.6168	<.0001
e_crp		1	0.9322	0.2683	12.0684	0.0005
age2	**1**	1	0.2299	0.3251	0.5002	0.4794
age2	**2**	1	-0.5985	0.2414	6.1459	0.0132
e_crp*age2	**1**	1	0.1515	0.4625	0.1073	0.7433
e_crp*age2	**2**	1	1.2015	0.4044	8.8253	0.0030
brfeed		1	0.2602	0.1917	1.8430	0.1746
HFA		1	0.4480	0.1830	5.9910	0.0144

Odds Ratio Estimates			
Effect	**Point Estimate**	**95% Wald Confidence Limits**	
brfeed	1.297	0.891	1.889
HFA	1.565	1.093	2.241

Association of Predicted Probabilities and Observed Responses			
Percent Concordant	67.2	**Somers' D**	0.413
Percent Discordant	25.9	**Gamma**	0.444
Percent Tied	6.9	**Tau-a**	0.203
Pairs	136425	**c**	0.707

Contrast Test Results			
Contrast	**DF**	**Wald Chi-Square**	**Pr > ChiSq**
24-35 Month	1	12.0684	0.0005
6-12 Month	1	8.7736	0.0031
12-24 Month	1	35.4501	<.0001

Contrast Estimation and Testing Results by Row								
Contrast	**Type**	**Row**	**Estimate**	**Standard Error**	**Alpha**	**Confidence Limits**		**Wald Chi-Square**	**Pr > ChiSq**
24-35 Month	**EXP**	**1**	2.5401	0.6816	0.05	1.5012	4.2979	12.0684	0.0005
6-12 Month	**EXP**	**1**	3.7195	1.6495	0.05	1.5595	8.8708	8.7736	0.0031
12-24 Month	**EXP**	**1**	4.6418	1.1968	0.05	2.8004	7.6939	35.4501	<.0001

Exposure: Any inflammation Outcome: Fever

```
*Full model with interaction terms;
Proc surveylogistic data=three;
   Cluster cluster;
   Class asset (REF='4') /param=ref;
   Class age2 (REF='3') /param=ref;
   Model fever24HR (Event='1') = inflam asset sex age2 mat_yr wfh hfa
brfeed inflam*asset inflam*sex inflam*age2 inflam*mat_yr inflam*wfh
inflam*hfa inflam*brfeed;
   Where fever24HR = 0 or fever24HR= 1;
run;
```

Model Convergence Status
Convergence criterion (GCONV=1E-8) satisfied.

Model Fit Statistics		
Criterion	**Intercept Only**	**Intercept and Covariates**
AIC	997.356	973.596
SC	1001.949	1083.829
-2 Log L	995.356	925.596

Testing Global Null Hypothesis: BETA=0			
Test	**Chi-Square**	**DF**	**Pr > ChiSq**
Likelihood Ratio	69.7603	23	<.0001
Score	66.4852	23	<.0001
Wald	105.8506	23	<.0001

Type 3 Analysis of Effects			
Effect	**DF**	**Wald Chi-Square**	**Pr > ChiSq**
inflam	1	0.0960	0.7566
asset	4	0.9280	0.9205
SEX	1	0.7770	0.3781
age2	2	4.3544	0.1134
mat_yr	1	1.8586	0.1728
WFH	1	0.0196	0.8887
HFA	1	1.6476	0.1993
brfeed	1	0.0558	0.8133
inflam*asset	4	3.8605	0.4252
inflam*SEX	1	0.5495	0.4585
inflam*age2	2	2.5315	0.2820
inflam*mat_yr	1	0.7935	0.3730
inflam*WFH	1	0.0820	0.7746
inflam*HFA	1	0.3255	0.5683
inflam*brfeed	1	1.3904	0.2383

Analysis of Maximum Likelihood Estimates						
Parameter		**DF**	**Estimate**	**Standard Error**	**Wald Chi-Square**	**Pr > ChiSq**
Intercept		1	0.3083	0.9443	0.1066	0.7441
inflam		1	-0.3441	1.1103	0.0960	0.7566
asset	**0**	1	-0.1649	0.4706	0.1228	0.7260
asset	**1**	1	-0.2408	0.4973	0.2345	0.6282
asset	**2**	1	-0.0280	0.4443	0.0040	0.9497
asset	**3**	1	0.1717	0.3842	0.1999	0.6548
SEX		1	-0.2439	0.2767	0.7770	0.3781
age2	**1**	1	0.2015	0.4817	0.1751	0.6756
age2	**2**	1	-0.5148	0.3883	1.7575	0.1849
mat_yr		1	-0.0286	0.0210	1.8586	0.1728
WFH		1	0.1647	1.1764	0.0196	0.8887
HFA		1	0.4519	0.3520	1.6476	0.1993
brfeed		1	-0.0814	0.3445	0.0558	0.8133
inflam*asset	**0**	1	0.6209	0.6010	1.0675	0.3015
inflam*asset	**1**	1	0.0184	0.5449	0.0011	0.9731
inflam*asset	**2**	1	-0.2008	0.5612	0.1280	0.7205
inflam*asset	**3**	1	-0.4681	0.5420	0.7459	0.3878
inflam*SEX		1	0.2349	0.3168	0.5495	0.4585
inflam*age2	**1**	1	-0.1295	0.5587	0.0538	0.8166
inflam*age2	**2**	1	0.5315	0.4927	1.1637	0.2807
inflam*mat_yr		1	0.0241	0.0271	0.7935	0.3730
inflam*WFH		1	0.3535	1.2342	0.0820	0.7746
inflam*HFA		1	-0.2328	0.4080	0.3255	0.5683
inflam*brfeed		1	0.5026	0.4262	1.3904	0.2383

```
*Drop inflam*wfh, p=.7746;
Proc surveylogistic data=three;
   Cluster cluster;
   Class asset (REF='4') /param=ref;
   Class age2 (REF='3') /param=ref;
   Model fever24HR (Event='1') = inflam asset sex age2 mat_yr wfh hfa
brfeed inflam*asset inflam*sex inflam*age2 inflam*mat_yr inflam*hfa
inflam*brfeed;
   Where fever24HR = 0 or fever24HR= 1;
run;
```

Model Fit Statistics		
Criterion	**Intercept Only**	**Intercept and Covariates**
AIC	997.356	971.666
SC	1001.949	1077.306
-2 Log L	995.356	925.666

Testing Global Null Hypothesis: BETA=0			
Test	**Chi-Square**	**DF**	**Pr > ChiSq**
Likelihood Ratio	69.6907	22	<.0001
Score	66.4180	22	<.0001
Wald	88.9410	22	<.0001

Type 3 Analysis of Effects			
Effect	**DF**	**Wald Chi-Square**	**Pr > ChiSq**
inflam	1	0.0990	0.7531
asset	4	0.8996	0.9246
SEX	1	0.7685	0.3807
age2	2	4.2878	0.1172
mat_yr	1	1.8728	0.1712
WFH	1	1.4650	0.2261
HFA	1	1.6181	0.2034
brfeed	1	0.0596	0.8071
inflam*asset	4	3.7892	0.4353
inflam*SEX	1	0.5458	0.4601
inflam*age2	2	2.4997	0.2865
inflam*mat_yr	1	0.7996	0.3712
inflam*HFA	1	0.3119	0.5765
inflam*brfeed	1	1.4063	0.2357

Analysis of Maximum Likelihood Estimates					
Parameter	**DF**	**Estimate**	**Standard Error**	**Wald Chi-Square**	**Pr > ChiSq**
Intercept	1	0.3142	0.9465	0.1102	0.7399

Analysis of Maximum Likelihood Estimates

Parameter		DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
inflam		1	-0.3500	1.1127	0.0990	0.7531
asset	**0**	1	-0.1651	0.4699	0.1235	0.7253
asset	**1**	1	-0.2452	0.4948	0.2456	0.6202
asset	**2**	1	-0.0326	0.4421	0.0054	0.9413
asset	**3**	1	0.1649	0.3858	0.1828	0.6690
SEX		1	-0.2435	0.2778	0.7685	0.3807
age2	**1**	1	0.1980	0.4804	0.1698	0.6803
age2	**2**	1	-0.5142	0.3862	1.7729	0.1830
mat_yr		1	-0.0288	0.0210	1.8728	0.1712
WFH		1	0.4714	0.3895	1.4650	0.2261
HFA		1	0.4490	0.3530	1.6181	0.2034
brfeed		1	-0.0839	0.3435	0.0596	0.8071
inflam*asset	**0**	1	0.6237	0.5988	1.0852	0.2975
inflam*asset	**1**	1	0.0230	0.5425	0.0018	0.9662
inflam*asset	**2**	1	-0.1933	0.5562	0.1207	0.7282
inflam*asset	**3**	1	-0.4616	0.5430	0.7227	0.3953
inflam*SEX		1	0.2345	0.3174	0.5458	0.4601
inflam*age2	**1**	1	-0.1237	0.5570	0.0493	0.8243
inflam*age2	**2**	1	0.5327	0.4905	1.1797	0.2774
inflam*mat_yr		1	0.0243	0.0271	0.7996	0.3712
inflam*HFA		1	-0.2285	0.4092	0.3119	0.5765
inflam*brfeed		1	0.5056	0.4264	1.4063	0.2357

```
*Drop inflam*hfa, p=.5765;
Proc surveylogistic data=three;
   Cluster cluster;
   Class asset (REF='4') /param=ref;
   Class age2 (REF='3') /param=ref;
   Model fever24HR (Event='1') = inflam asset sex age2 mat_yr wfh hfa
brfeed inflam*asset inflam*sex inflam*age2 inflam*mat_yr inflam*brfeed;
   Where fever24HR = 0 or fever24HR= 1;
run;
```

Model Fit Statistics

Criterion	Intercept Only	Intercept and Covariates
AIC	997.356	969.998
SC	1001.949	1071.045
-2 Log L	995.356	925.998

Testing Global Null Hypothesis: BETA=0

Test	Chi-Square	DF	Pr > ChiSq
Likelihood Ratio	69.3581	21	<.0001
Score	66.2536	21	<.0001
Wald	88.4974	21	<.0001

Type 3 Analysis of Effects

Effect	DF	Wald Chi-Square	Pr > ChiSq
inflam	1	0.1772	0.6738
asset	4	0.9099	0.9231
SEX	1	0.8942	0.3443
age2	2	4.1755	0.1240
mat_yr	1	1.9375	0.1639
WFH	1	1.4273	0.2322
HFA	1	2.7929	0.0947
brfeed	1	0.0530	0.8179
inflam*asset	4	3.7981	0.4340
inflam*SEX	1	0.7005	0.4026
inflam*age2	2	2.4121	0.2994
inflam*mat_yr	1	0.8101	0.3681
inflam*brfeed	1	1.4286	0.2320

Analysis of Maximum Likelihood Estimates

Parameter		DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept		1	0.4039	0.9600	0.1771	0.6739
inflam		1	-0.4653	1.1055	0.1772	0.6738
asset	**0**	1	-0.1654	0.4726	0.1225	0.7263

Analysis of Maximum Likelihood Estimates

Parameter		DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
asset	**1**	1	-0.2303	0.4827	0.2277	0.6332
asset	**2**	1	-0.0262	0.4404	0.0035	0.9526
asset	**3**	1	0.1733	0.3847	0.2028	0.6525
SEX		1	-0.2632	0.2783	0.8942	0.3443
age2	**1**	1	0.1591	0.4681	0.1155	0.7340
age2	**2**	1	-0.5208	0.3820	1.8592	0.1727
mat_yr		1	-0.0297	0.0213	1.9375	0.1639
WFH		1	0.4651	0.3893	1.4273	0.2322
HFA		1	0.2961	0.1772	2.7929	0.0947
brfeed		1	-0.0780	0.3389	0.0530	0.8179
inflam*asset	**0**	1	0.6182	0.5985	1.0670	0.3016
inflam*asset	**1**	1	-0.00088	0.5290	0.0000	0.9987
inflam*asset	**2**	1	-0.1986	0.5550	0.1280	0.7205
inflam*asset	**3**	1	-0.4698	0.5407	0.7549	0.3849
inflam*SEX		1	0.2608	0.3116	0.7005	0.4026
inflam*age2	**1**	1	-0.0666	0.5473	0.0148	0.9031
inflam*age2	**2**	1	0.5497	0.4864	1.2776	0.2583
inflam*mat_yr		1	0.0247	0.0274	0.8101	0.3681
inflam*brfeed		1	0.5054	0.4228	1.4286	0.2320

```
*Drop inflam*asset, p=.4340;
Proc surveylogistic data=three;
   Cluster cluster;
   Class asset (REF='4') /param=ref;
   Class age2 (REF='3') /param=ref;
   Model fever24HR (Event='1') = inflam asset sex age2 mat_yr wfh hfa
brfeed inflam*sex inflam*age2 inflam*mat_yr inflam*brfeed;
   Where fever24HR = 0 or fever24HR= 1;
run;
```

Model Fit Statistics

Criterion	Intercept Only	Intercept and Covariates
AIC	997.356	965.540

Model Fit Statistics		
Criterion	**Intercept Only**	**Intercept and Covariates**
SC	1001.949	1048.214
-2 Log L	995.356	929.540

Testing Global Null Hypothesis: BETA=0			
Test	**Chi-Square**	**DF**	**Pr > ChiSq**
Likelihood Ratio	65.8167	17	<.0001
Score	62.7141	17	<.0001
Wald	80.4162	17	<.0001

Type 3 Analysis of Effects			
Effect	**DF**	**Wald Chi-Square**	**Pr > ChiSq**
inflam	1	0.1443	0.7041
asset	4	4.9426	0.2932
SEX	1	0.7755	0.3785
age2	2	4.5112	0.1048
mat_yr	1	1.4602	0.2269
WFH	1	1.6106	0.2044
HFA	1	3.1228	0.0772
brfeed	1	0.0837	0.7723
inflam*SEX	1	0.6436	0.4224
inflam*age2	2	2.6397	0.2672
inflam*mat_yr	1	0.4895	0.4841
inflam*brfeed	1	1.6122	0.2042

Analysis of Maximum Likelihood Estimates					
Parameter		**DF**	**Estimate**	**Standard Error**	**Wald Chi-Square**	**Pr > ChiSq**
Intercept		1	0.3258	0.9245	0.1242	0.7245
inflam		1	-0.3693	0.9722	0.1443	0.7041
asset	**0**	1	0.2864	0.2799	1.0470	0.3062
asset	**1**	1	-0.2286	0.2821	0.6565	0.4178

Analysis of Maximum Likelihood Estimates

Parameter		DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
asset	**2**	1	-0.1557	0.2168	0.5156	0.4727
asset	**3**	1	-0.1348	0.2337	0.3329	0.5640
SEX		1	-0.2475	0.2811	0.7755	0.3785
age2	**1**	1	0.1878	0.4791	0.1536	0.6951
age2	**2**	1	-0.5415	0.3885	1.9422	0.1634
mat_yr		1	-0.0261	0.0216	1.4602	0.2269
WFH		1	0.5041	0.3972	1.6106	0.2044
HFA		1	0.3141	0.1777	3.1228	0.0772
brfeed		1	-0.0980	0.3388	0.0837	0.7723
inflam*SEX		1	0.2504	0.3121	0.6436	0.4224
inflam*age2	**1**	1	-0.1111	0.5522	0.0405	0.8406
inflam*age2	**2**	1	0.5622	0.4962	1.2836	0.2572
inflam*mat_yr		1	0.0191	0.0273	0.4895	0.4841
inflam*brfeed		1	0.5387	0.4243	1.6122	0.2042

```
*Drop inflam*mat_yr, p=.4841;
Proc surveylogistic data=three;
   Cluster cluster;
   Class asset (REF='4') /param=ref;
   Class age2 (REF='3') /param=ref;
   Model fever24HR (Event='1') = inflam asset sex age2 mat_yr wfh hfa
brfeed inflam*age2 inflam*sex inflam*brfeed;
   Where fever24HR = 0 or fever24HR= 1;
run;
```

Model Fit Statistics

Criterion	Intercept Only	Intercept and Covariates
AIC	997.356	964.247
SC	1001.949	1042.328
-2 Log L	995.356	930.247

Testing Global Null Hypothesis: BETA=0

Test	Chi-Square	DF	Pr > ChiSq

Testing Global Null Hypothesis: BETA=0			
Test	**Chi-Square**	**DF**	**Pr > ChiSq**
Likelihood Ratio	65.1096	16	<.0001
Score	62.3482	16	<.0001
Wald	76.3752	16	<.0001

Type 3 Analysis of Effects			
Effect	**DF**	**Wald Chi-Square**	**Pr > ChiSq**
inflam	1	0.1583	0.6908
asset	4	4.9027	0.2974
SEX	1	0.7338	0.3916
age2	2	4.4229	0.1095
mat_yr	1	1.4085	0.2353
WFH	1	1.4916	0.2220
HFA	1	3.3778	0.0661
brfeed	1	0.1044	0.7466
inflam*age2	2	2.6137	0.2707
inflam*SEX	1	0.5923	0.4415
inflam*brfeed	1	1.7278	0.1887

Analysis of Maximum Likelihood Estimates						
Parameter		**DF**	**Estimate**	**Standard Error**	**Wald Chi-Square**	**Pr > ChiSq**
Intercept		1	-0.0276	0.6647	0.0017	0.9669
inflam		1	0.1799	0.4521	0.1583	0.6908
asset	**0**	1	0.2774	0.2836	0.9572	0.3279
asset	**1**	1	-0.2379	0.2826	0.7087	0.3999
asset	**2**	1	-0.1645	0.2188	0.5653	0.4521
asset	**3**	1	-0.1368	0.2346	0.3401	0.5598
SEX		1	-0.2345	0.2738	0.7338	0.3916
age2	**1**	1	0.2250	0.4752	0.2243	0.6358
age2	**2**	1	-0.4962	0.3764	1.7377	0.1874
mat_yr		1	-0.0142	0.0120	1.4085	0.2353
WFH		1	0.4915	0.4024	1.4916	0.2220

Analysis of Maximum Likelihood Estimates						
Parameter		**DF**	**Estimate**	**Standard Error**	**Wald Chi-Square**	**Pr > ChiSq**
HFA		1	0.3287	0.1788	3.3778	0.0661
brfeed		1	-0.1064	0.3292	0.1044	0.7466
inflam*age2	**1**	1	-0.1508	0.5463	0.0761	0.7826
inflam*age2	**2**	1	0.5230	0.4798	1.1886	0.2756
inflam*SEX		1	0.2355	0.3060	0.5923	0.4415
inflam*brfeed		1	0.5465	0.4158	1.7278	0.1887

```
*Drop inflam*sex, p=.4415;
Proc surveylogistic data=three;
   Cluster cluster;
   Class asset (REF='4') /param=ref;
   Class age2 (REF='3') /param=ref;
   Model fever24HR (Event='1') = inflam asset sex age2 mat_yr wfh hfa
brfeed inflam*age2 inflam*brfeed;
   Where fever24HR = 0 or fever24HR= 1;
run;
```

Model Fit Statistics		
Criterion	**Intercept Only**	**Intercept and Covariates**
AIC	997.356	962.736
SC	1001.949	1036.225
-2 Log L	995.356	930.736

Testing Global Null Hypothesis: BETA=0			
Test	**Chi-Square**	**DF**	**Pr > ChiSq**
Likelihood Ratio	64.6202	15	<.0001
Score	62.0319	15	<.0001
Wald	75.7146	15	<.0001

Type 3 Analysis of Effects			
Effect	**DF**	**Wald Chi-Square**	**Pr > ChiSq**
inflam	1	5.5160	0.0188
asset	4	4.9724	0.2901

Type 3 Analysis of Effects

Effect	DF	Wald Chi-Square	Pr > ChiSq
SEX	1	0.2436	0.6216
age2	2	4.4603	0.1075
mat_yr	1	1.3695	0.2419
WFH	1	1.4606	0.2268
HFA	1	3.4395	0.0637
brfeed	1	0.0993	0.7527
inflam*age2	2	2.6171	0.2702
inflam*brfeed	1	1.7577	0.1849

Analysis of Maximum Likelihood Estimates

Parameter		DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept		1	-0.2670	0.5552	0.2313	0.6306
inflam		1	0.5166	0.2200	5.5160	0.0188
asset	**0**	1	0.2976	0.2812	1.1197	0.2900
asset	**1**	1	-0.2275	0.2808	0.6563	0.4179
asset	**2**	1	-0.1530	0.2204	0.4822	0.4874
asset	**3**	1	-0.1213	0.2292	0.2801	0.5966
SEX		1	-0.0777	0.1574	0.2436	0.6216
age2	**1**	1	0.2089	0.4677	0.1996	0.6551
age2	**2**	1	-0.5012	0.3773	1.7649	0.1840
mat_yr		1	-0.0140	0.0120	1.3695	0.2419
WFH		1	0.4908	0.4061	1.4606	0.2268
HFA		1	0.3310	0.1785	3.4395	0.0637
brfeed		1	-0.1039	0.3297	0.0993	0.7527
inflam*age2	**1**	1	-0.1356	0.5381	0.0635	0.8010
inflam*age2	**2**	1	0.5334	0.4806	1.2319	0.2670
inflam*brfeed		1	0.5484	0.4137	1.7577	0.1849

```
*Drop inflam*age2, p=.3797;
Proc surveylogistic data=three;
   Cluster cluster;
   Class asset (REF='4') /param=ref;
```

```
   Class age2 (REF='3') /param=ref;
   Model fever24HR (Event='1') = inflam asset sex age2 mat_yr wfh hfa
brfeed inflam*brfeed;
   Where fever24HR = 0 or fever24HR= 1;
run;
```

Model Fit Statistics

Criterion	Intercept Only	Intercept and Covariates
AIC	997.356	961.497
SC	1001.949	1025.800
-2 Log L	995.356	933.497

Testing Global Null Hypothesis: BETA=0

Test	Chi-Square	DF	Pr > ChiSq
Likelihood Ratio	61.8593	13	<.0001
Score	60.0062	13	<.0001
Wald	78.8120	13	<.0001

Type 3 Analysis of Effects

Effect	DF	Wald Chi-Square	Pr > ChiSq
inflam	1	9.3601	0.0022
asset	4	4.8172	0.3066
SEX	1	0.1961	0.6579
age2	2	1.5071	0.4707
mat_yr	1	1.1793	0.2775
WFH	1	1.6191	0.2032
HFA	1	3.2446	0.0717
brfeed	1	0.5501	0.4583
inflam*brfeed	1	5.7936	0.0161

Analysis of Maximum Likelihood Estimates

Parameter		DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept		1	-0.4192	0.5043	0.6910	0.4058
inflam		1	0.6471	0.2115	9.3601	0.0022
asset	**0**	1	0.3037	0.2774	1.1983	0.2737

Analysis of Maximum Likelihood Estimates

Parameter		DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
asset	**1**	1	-0.2138	0.2745	0.6068	0.4360
asset	**2**	1	-0.1384	0.2202	0.3953	0.5295
asset	**3**	1	-0.1013	0.2292	0.1953	0.6586
SEX		1	-0.0688	0.1553	0.1961	0.6579
age2	**1**	1	0.1224	0.3236	0.1432	0.7052
age2	**2**	1	-0.1444	0.2056	0.4931	0.4826
mat_yr		1	-0.0122	0.0113	1.1793	0.2775
WFH		1	0.5159	0.4055	1.6191	0.2032
HFA		1	0.3158	0.1753	3.2446	0.0717
brfeed		1	-0.1767	0.2383	0.5501	0.4583
inflam*brfeed		1	0.6509	0.2704	5.7936	0.0161

```
Proc surveylogistic data=three;
   Cluster cluster;
   Class asset (REF='4') /param=ref;
   Class age2 (REF='3') /param=ref;
   Model fever24HR (Event='1') = inflam asset sex age2 mat_yr wfh hfa
brfeed inflam*brfeed;
   Where fever24HR = 0 or fever24HR= 1;
   Contrast "Breastfeeding" inflam 1 brfeed 1 inflam*brfeed 1/est=exp;
   Contrast "Not Breastfeeding" inflam 1 brfeed 0 inflam*brfeed
0/est=exp;
run;
```

Model Fit Statistics

Criterion	Intercept Only	Intercept and Covariates
AIC	997.356	961.497
SC	1001.949	1025.800
-2 Log L	995.356	933.497

Testing Global Null Hypothesis: BETA=0

Test	Chi-Square	DF	Pr > ChiSq
Likelihood Ratio	61.8593	13	<.0001
Score	60.0062	13	<.0001
Wald	78.8120	13	<.0001

Type 3 Analysis of Effects

Effect	DF	Wald Chi-Square	Pr > ChiSq
inflam	1	9.3601	0.0022
asset	4	4.8172	0.3066
SEX	1	0.1961	0.6579
age2	2	1.5071	0.4707
mat_yr	1	1.1793	0.2775
WFH	1	1.6191	0.2032
HFA	1	3.2446	0.0717
brfeed	1	0.5501	0.4583
inflam*brfeed	1	5.7936	0.0161

Analysis of Maximum Likelihood Estimates

Parameter		DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept		1	-0.4192	0.5043	0.6910	0.4058
inflam		1	0.6471	0.2115	9.3601	0.0022
asset	**0**	1	0.3037	0.2774	1.1983	0.2737
asset	**1**	1	-0.2138	0.2745	0.6068	0.4360
asset	**2**	1	-0.1384	0.2202	0.3953	0.5295
asset	**3**	1	-0.1013	0.2292	0.1953	0.6586
SEX		1	-0.0688	0.1553	0.1961	0.6579
age2	**1**	1	0.1224	0.3236	0.1432	0.7052
age2	**2**	1	-0.1444	0.2056	0.4931	0.4826
mat_yr		1	-0.0122	0.0113	1.1793	0.2775
WFH		1	0.5159	0.4055	1.6191	0.2032
HFA		1	0.3158	0.1753	3.2446	0.0717
brfeed		1	-0.1767	0.2383	0.5501	0.4583
inflam*brfeed		1	0.6509	0.2704	5.7936	0.0161

Odds Ratio Estimates

Effect	Point Estimate	95% Wald Confidence Limits	
asset 0 vs 4	1.355	0.787	2.333

Odds Ratio Estimates

Effect	Point Estimate	95% Wald Confidence Limits	
asset 1 vs 4	0.807	0.471	1.383
asset 2 vs 4	0.871	0.566	1.341
asset 3 vs 4	0.904	0.577	1.416
SEX	0.934	0.689	1.266
age2 1 vs 3	1.130	0.599	2.131
age2 2 vs 3	0.866	0.578	1.295
mat_yr	0.988	0.966	1.010
WFH	1.675	0.757	3.709
HFA	1.371	0.973	1.934

Association of Predicted Probabilities and Observed Responses

Percent Concordant	66.4	**Somers' D**	0.333
Percent Discordant	33.1	**Gamma**	0.335
Percent Tied	0.4	**Tau-a**	0.163
Pairs	130200	**c**	0.667

Contrast Test Results

Contrast	DF	Wald Chi-Square	Pr > ChiSq
Breastfeeding	1	17.6159	<.0001
Not Breastfeeding	1	9.3601	0.0022

Contrast Estimation and Testing Results by Row

Contrast	Type	Row	Estimate	Standard Error	Alpha	Confidence Limits		Wald Chi-Square	Pr > ChiSq
Breastfeeding	**EXP**	**1**	3.0687	0.8198	0.05	1.8179	5.1803	17.6159	<.0001
Not Breastfeeding	**EXP**	**1**	1.9100	0.4040	0.05	1.2618	2.8911	9.3601	0.0022

```
*Drop all covariates but brfeed and inflam*brfeed;
Proc surveylogistic data=three;
   Cluster cluster;
   Class asset (REF='4') /param=ref;
   Class age2 (REF='3') /param=ref;
```

```
   Model fever24HR (Event='1') = inflam brfeed inflam*brfeed;
   Where fever24HR = 0 or fever24HR= 1;
   Contrast "Breastfeeding" inflam 1 brfeed 1 inflam*brfeed 1/est=exp;
   Contrast "Not Breastfeeding" inflam 1 brfeed 0 inflam*brfeed
0/est=exp;
run;
```

Model Convergence Status

Convergence criterion (GCONV=1E-8) satisfied.

Model Fit Statistics

Criterion	Intercept Only	Intercept and Covariates
AIC	1024.441	978.012
SC	1029.059	996.482
-2 Log L	1022.441	970.012

Testing Global Null Hypothesis: BETA=0

Test	Chi-Square	DF	Pr > ChiSq
Likelihood Ratio	52.4291	3	<.0001
Score	51.3575	3	<.0001
Wald	46.5995	3	<.0001

Analysis of Maximum Likelihood Estimates

Parameter	DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept	1	-0.8582	0.1604	28.6115	<.0001
inflam	1	0.6880	0.2107	10.6671	0.0011
brfeed	1	-0.1731	0.2181	0.6299	0.4274
inflam*brfeed	1	0.6757	0.2794	5.8475	0.0156

Association of Predicted Probabilities and Observed Responses

Percent Concordant	51.9	**Somers' D**	0.291
Percent Discordant	22.9	**Gamma**	0.389
Percent Tied	25.2	**Tau-a**	0.143
Pairs	137172	**c**	0.645

Contrast Test Results

Contrast	DF	Wald Chi-Square	Pr > ChiSq
Breastfeeding	1	31.9033	<.0001
Not Breastfeeding	1	10.6671	0.0011

Contrast Estimation and Testing Results by Row

Contrast	Type	Row	Estimate	Standard Error	Alpha	Confidence Limits		Wald Chi-Square	Pr > ChiSq
Breastfeeding	**EXP**	**1**	3.2890	0.6933	0.05	2.1759	4.9714	31.9033	<.0001
Not Breastfeeding	**EXP**	**1**	1.9897	0.4191	0.05	1.3167	3.0068	10.6671	0.0011

Appendix B: Questionnaire

FOLLOW-UP HOUSEHOLD QUESTIONNAIRE

TEAM CODE: _____ INTERVIEWER CODE: _____ TODAY'S DATE: _____/_____/2010

HOUSEHOLD – DEMOGRAPHICS

The household questionnaire should be completed by an adult living in the selected household.

H1. SUBLOCATION **SUBLOCID** (CIRCLE ONE)	01-Achego 02-Ahero 03- Ayucha 04-Ayweyo 05- Border 1 06- Border 2 07-Kobongo 08- Kakmie 09- Katolo 10-Kochogo Central 11-Kochogo North 12-Kochogo south 13-Magina 14-Nyakongo 15-Ombaka 16-Wanganga
H2. VILLAGE **VILLAGENAME**	----------
H3. CLUSTER NUMBER **CLUSTER** *(ENTER FROM CLUSTER LISTING FORM)*	☐☐
H4. **NYING WUON DALA EN NG'A?** NAME OF THE COMPOUND HEAD **DALANAME**	----------
H5. DALA NUMBER **DALANUMBER** *(ENTER FROM CLUSTER LISTING FORM)*	☐☐
H6. HOUSEHOLD ID **HHID**	☐☐ ☐☐ ☐☐ ☐☐ subloc cluster dala # HH #
H7. **NYINGI EN NG'A?** RESPONDENT'S NAME **RESPNAME**	----------
H8. **HIKI ADI ?** RESPONDENT'S AGE **RAGE**	☐☐ years
H9. **RESPONDENT'S SEX** **RSEX**	Male (**wuoyi**) ..... 1 Female(**nyako**)..... 2
H10. **OD NI MARU KOSO UPANGO?** **OWNRENT** ARE YOU TENANTS IN THIS HOUSE OR IS IT OWNED BY THE FAMILY?	Owned (**ot mari**) ..... 1 Rented (**ikodesa**)..... 2

H11. **OT KA RUM ADI MA JI NINDE?** **ROOMNUM** HOW MANY ROOMS IN THE HOUSE ARE USED FOR SLEEPING?	_____ Rooms (**rums)**
H12. **UN GI STIMA E ODU KA?** **ELECTRICITY** IS THERE ELECTRICITY IN THIS HOUSE?	No (**ooyo)**..... 0 Yes (**eeh)**..... 1 Don't know (**ok ang'eyo)** 99

H13. **BE UN GI:** DO YOU CURRENTLY HAVE ANY OF THE FOLLOWING IN YOUR HOUSE?
(Read. Mark all that apply)

Item	No **(ooyo)**= 0 Yes **(eeh)**= 1
NYAKALONDO (RADIO) **Radio**	0 1
TELEBISEN (TELEVISION**) TV**	0 1
FRIJ (REFRIGERATOR**) Refrig**	0 1
NDIGA (BICYCLE**) Bike**	0 1
PIKIPIKI (MOTORCYCLE**) Piki**	0 1
MATOKA (A CAR) **Car**	0 1
SIMB JOPOSTA (LANDLINE TELEPHONE**) TelLand**	0 1
SIMB ONG'WE YAMO (MOBILE PHONE**) TelCell**	0 1
JATICH MONDIKI (A HOUSEHELP**) DomWork**	0 1

Household SWAP Module

H14. **BENDE IN KATA JAODNI MORO EN JAUSO MAR SWAP? Vendor** ARE YOU OR ANYONE IN YOUR HOUSEHOLD A SWAP VENDOR?	No(**podi**)…….. ..0 Yes(**ase ngiew'o**)……..……1	
H15. **BENDE JAUS GIGE SWAP/NICHE OSEBIRO E ODU KA? SwapVisit** HAS ANY VENDOR VISITED YOUR HOUSE TO SELL HEALTH PRODUCTS?	No(**podi**)……..……...0 Yes(**osebiro**)……..……1 Don't know (**ok ang'eyo**)……..……99	**IF NO OR DK, GO TO H18**
H16. **BENDE NING'IEWO GIR SWAP/NICHE MORO AMORA? BuySWAP**	No(**podi**)……	**IF NO**

DID YOU BUY ANY HEALTH PRODUCTS?	..0 Yes(**ase ngiew'o**)……..……..……1 Don't know (**ok ang'eyo**)……..……99	**or DK , GO TO H18**
H17. **ANG'O MANING'IEWO?** DID YOU BUY? *(Read. Mark all that apply)*	WaterGuard(**waterguard)** **BuySWAPWG**.....0 / 1 PUR (**PUR**) **BuySWAPPUR**……..... 0 / 1 Modified Clay Pot(**agulu molos man gi fereji)**…0 / 1 Bednets (ITN) (**net mar suna)** …….....0 / 1 Condoms(**kondom)**…**BuySWAPcon**…….. ....0 / 1 Sprinkles… **BuySWAPSpr**..…….…… 0 / 1 Fortified Flour(**mogo mayom) BuySwapFlow** 0 / 1 Soap(**sabun)BuySwapSoap**…….. ...0 / 1 Savlon(**yath mar savlon)BuySwapSav**……..0 / 1 Other(**moro mopogore)BuySwapOth**……...0 / 1 Don't know (**ok ang'eyo)BuySwapDK**……0 / 1	

WATER & HYGIENE MODULE **Read: "Now we would like to talk with you about the water you use in your home"**	
H18. **PI MA UMODHO E OT KAE KAWUONO UYUDO KOA KANYE? HHSRC** WHAT DRINKING WATER SOURCE ARE YOU USING TODAY? *(Don't read. Mark only one)*	Pond (**Dago**), River (**Aora**), Dam / Earthpan (**Yawo**), or Lake (**Nam**) ..... 1 Borehole **(Kisima mokuny gi masin)**..... 2 Rain water catchment **(Pii koth)** ..... 3 Covered Well **(Kisima manigi pump)**..... 4 Open Well **(Kisima maonge pump)** ..... 5 Spring **(Soko moger)**..... 6

	Piped Water **(Pii fereji)** ..... 7 Water vendors **(Jo us pii)** ..... 8 From school **(skul)**……..……9 Other **moro mopogore** ……..……88 Don't know(**ok ang'eyo)**……..……..99	
H19. **BENDE NITIE GIMA UTIMO NE PI MONDO OBED MABER MAR MODHO?** **WATSAFE** DO YOU DO ANYTHING TO THE WATER TO MAKE IT SAFE FOR DRINKING?	No **(da)**……..... .0 Yes**(nitie)**……..……..… …1 Don't know (**ok ang'eyo)**……..……99	**IF NO OR DK, GO TO H21**
H20. **ANG'O MAITIMONE?** WHAT DO YOU DO TO IT? (DON'T READ. MARK ALL THAT APPLY)	Use WaterGuard **(atiyo gi waterguard)**…. ……..... 1 Boil water (**chwako pii)** …… 1 Filter water (**a chungo pii)** …..... 1 Use PuR (**atiyo gi PUR)**..... 1 Use Aluminum sulphate- (**atiyo gi Aluminium)**…. 1 Other **(moro mopogore)** …….. 1	
H21. **BENDE UKANO PI MODHO?** **Store** DO YOU STORE DRINKING WATER?	No**(ok wa kan)**…..0 Yes**(wakano)**……..……1	**IF NO, GO TO H23**
H22. **UKANO PI MODHONO E ANG'O?** **StoreWat** WHERE DO YOU STORE THE DRINKING WATER? *(DON'T READ. MARK ONLY ONE)*	Plastic jerrycan(**kube mar plastic)** ……..……1 Buckets(**ndoo)** ……..……2 Ordinary clay pot(**agulu)** ……..……3 Improved clay pot (narrow mouth with tap) (**agulu moketi e tap)**……..……4	

	Barrel (**pipa/daram mar pii)** ……..…….5 Do not store drinking water.....6 Other **moro mopogore**……..……..88	
H23. **BENDE ISEWINJO WATERGUARD? HearWG** HAVE YOU HEARD ABOUT WATER GUARD?	No (**podi)**……..…….. .0 Yes (**asewinjo)**……..…… 1 Don't know (**ok ang'eyo)**…….……..……99	**IF NO OR DK, GO TO H32**
H24. **NIWINJE KOA KANYE?** (If Yes) WHERE DID YOU HEAR ABOUT IT? *(Don't read. Mark all that apply)*	Radio (**redio)**… ……..…….. 1 Newspaper (**gaset)** ……..... 1 My child in school (**nyathina manie skul)** ….... 1 Brochure/Poster (**kalatas mondiki mar lendo** .. 1 WaterGuard t-shirt **(T-shat mar WaterGuard)**… 1 Community Resource Persons (**jogo matiyo e gweng')**……..…….. ….. 1 Promotion show(**tuke mag lendo)** ……..……. 1 Community meetings/chiefs baraza (**chokruok/barasa)**…….. . 1 CARE Kenya (**jo CARE Kenya)**…….. 1 Wall painting(**picha mar korot maduong')**….. 1 Health facility (**kar thieth)**..…… 1 Neighbor / family / friends (**jogo ma wadak**	

	go/osiepe) …… 1 Health Officer/Nurse (**jathieth/sista matiyo e hospital)** ……..…. 1 SWAP/NICHE… …… 1 Other **(moro mopogore)**… ……..…….. 1
H25. **WATER GUARD MAROMO NADE MA ITIYOGO E LITA 20 MAR PI MALER?** HOW MUCH WATER GUARD DO YOU USE TO TREAT 20LITERS OF CLEAN WATER? **WGClear** *(DON'T READ. MARK ONLY ONE)*	One capful(**wi chupa achiel)**……..……1 Other **(moro mopogore)** ……..……88 Don't know (**ok ang'eyo)** ……..… 99
H26. **WATERGUARD MAROMO NADE MA ITIYOGO E LITA 20 MAR PI MA OLIL?** HOW MUCH WATER GUARD DO YOU USE TO TREAT 20L of DIRTY WATER? **WGTurb** *(DON'T READ. MARK ONLY ONE)*	Two capfuls(**wi chupa ariyo)**……1 Don't have or use turbid water (**ok ati gi pii dago/molil)** ……..……2 Other **(moro mopogore)**……..……..88 Don't know (**ok ang'eyo)**……..… 99
H27. **KA ISETHIEDHO PIGI GI WATERGUARD OBER MAR MODHO BANG' SECHE ADI?** AFTER HOW LONG IS THE WATER TREATED WITH WATERGUARD SAFE FOR DRINKING? **WGWAIT**	Less than 20 minutes **(matin ne dakika 20)** …...1 20 minutes or more **(dakika 20 kata mokalo)** ….2 Don't know **(ok ang'eyo)**……..……99
H28. **BENDE ISEGATHIEDHO PIGI GI WATERGUARD?**	No (**podi)**……..... 0 **IF NO**

HAVE YOU EVER TREATED YOUR WATER WITH WATER GUARD? **WGEverTrt**	Yes (**asethiedhe**)……..…… 1 Don't know **(ok ang'eyo)** ……..…… 99	**OR DK, GO TO H30**
H29. **PI MA UMODHO SANI BENDE OTHIEDH GI WATERGUARD? WGCurTrt** IS THE WATER YOU ARE DRINKING CURRENTLY TREATED WITH WATER GUARD**?**	No (**ok othiedhe**)…....0 Yes (**othiedhe**)…….……..1 Don't know **(ok ang'eyo)**…… 99	**IF YES OR DK, GO TO H31**
H30. (IF NO) **ANG'O MOMIYO?** WHY IS THAT? *(DON'T READ. MARK ALL THAT APPLY)*	Expensive(**beche tek**) ……... 1 Bad taste/smell (**ok omit/dum marach)** ……..... 1 It resembles jik (**ochal gi jik)** …… 1 Don't need (**ok adwar)** ……..… 1 Too difficult to use (**otek tiyo go)** ……..... 1 Don't know where to buy it (**ok ang'eyo kuma ing'iewe)** …… 1 Other **(moro mopogore)** …..……1 Don't know (**ok ang'eyo)** ……1	All responss go to H31
H31. **SANI BENDE IN GI SABUN EI OT KA?** DO YOU CURRENTLY HAVE SOAP IN THE HOUSE? **Soap**	No (**onge)**……..……0 Yes (**an go)**……..……1 Don't know **(ok ang'eyo)**…… 99	
H32. **UTIYO GI CHOO MANE?** WHAT TOILET FACILITY DO YOU USE? **Toilet** *(DON'T READ. MARK ONLY ONE)*	In the bush or on the ground (**e bungu kata laro)**1 Latrine(**choo mokuny)** ……..……2 Flush toilet(**choo mantie e ot)** ……..……3 River(**aora)** ……..……4 Other **(moro mopogore)** ……..……88	

HH – OBSERVATIONS		
H33. WHAT TYPE OF **ROOFING** DOES THIS HOUSE HAVE? **ROOF**	Thatch (**lum**)……1 Iron sheet(**mabati**) ……2 Tile/Asbestos sheets (**tail miketo e wi ot**) ….…3 Wood ***(bao)***……4 Cement (**simiti**) ……5 Other **(moro mopogore)** ……88	
H34. WHAT IS THE **FLOORING** MATERIAL? **FLOOR**	Dung/Mud (**owuoyo/loo**) ……1 Metal **(chuma)** ……2 Wood (**bao**)……3 Cement(**simiti**) ……4 Tile/Linoleum **(tail)** ……5 Other **moro mopogore** ……88	
H35. WHAT IS THE MATERIAL USED FOR THE **WALLS**? **WALL**	Dung/Mud (**owuoyo/loo**) ……1 Metal(**chuma**) ……2 Wood(**bao**) ……3 Cement/Plaster(**simiti**) ……4 Bricks/blocks/stones(**matafari/kite**)..……5 Other **moro mopogore** ……88	
H36. **BENDE ANYALO NENO GI MA IKANO E PII MAR MODHO?** MAY I SEE YOUR DRINKING WATER CONTAINER? **ObsStore**	Plastic jerrycan(**kube mar juala**) ……1 Buckets(**ndoo**)…… .....2 Ordinary clay pot(**agulu**) ……3 Improved clay pot (narrow mouth with tap) (**agulu man gi tap**) ……4 Barrel(**pipa/daram**) ……5 Container not present(**gir pii ong'e**)	**IF REFUSE or not present, GO TO H39**

	……6 Refused (**otamore)** ……..……77 Other **(moro mopogore)** ……..……88
H37. *Confirm presence of **lid**.* ***ObsLid***	No (**onge)**……..……...0 Yes (**nitie**)……..……1
H38. *Test drinking water **ObsChlor***	Negative (clear) (**ler)**……..……..... 0 Positive (pink) **(ratong'**)…….. 1 No water in the container(**pii onge E kube)**……..…2
H39. **KELE WATERGUARD MA INGODO ANEE?** CAN I SEE YOUR WATERGUARD? **ObsWG**	Absent (**onge)**..……..……..…… 0 Present(**nitie)**……..…….. 1 Refused **(otamore)**……..… 77
H40. **BENDE ANYALO NENO KALENDANI MAR SPRINKLES?** May I see your Sprinkles calendar? **ObsCal**	Absent (onge)……. 0 Present ……..……..……1 Refused (otamore)……..……. 77

HHID

MOTHER OF CHILD QUESTIONNAIRE

MOTHER DEMOGRAPHICS

The household questionnaire should be completed by the mother or caretaker for each child 6-35 months of age from each selected household.

M1. **NYING MAMA** MOTHER'S NAME	_____
M2. **HIK MAMA MOMAGE** MOTHER'S AGE	☐☐ Years
M3. **ICHOPO E OKANG' MANE MAR SOMO?** WHAT IS YOUR HIGHEST LEVEL OF EDUCATION **MomEduc**	None (**Onge**) ……1 Some Primary School **(Ok otieko primari skul)**……2 Completed Primary **(Otieko primary)** ……...3 Some Secondary School **(Ok otieko secondary)**…..4 Completed Secondary School **(Otieko secondary)**...5 Any Trade School or University **(Skul mamoko kata mbalariany)** ……..6 Other (**Mamoko**)……..…88 Don't know (**Akia)** ……. 99
M4**. BENDE JOODI NE NITIERE NONRO MAR JO NICHE MANE ILIMO JI BANG' JUMBE ARIYO?** DID YOUR HOUSEHOLD PARTICIPATE IN THE NICHE STUDY WHERE PEOPLE VISITED THE HOUSE APPROXIMATELY EVERY TWO WEEKS? **NICHEHH**	No, never……0 Yes……..…..1 Don't know……..99

MOTHER SPRINKLES

Koro wadwaro wuoyo e wi gimachielo

"Now we would like to talk with you about a different subject."

M5. **BENDE ISEWINJO KATA NENO GIMA ILUONGO NI 'SPRINKLES'?** HAVE YOU EVER HEARD OF SPRINKLES? **HearSP** ***(Show sachet of Sprinkles)***	No **(Podi)** …… … ……...0 Yes (**Eee)** …… … ……1	**IF NO, GO TO M7**

M6. **NIWINJO 'SPRINKLES' NI KANYE?** DID YOU HEAR ABOUT SPRINKLES FROM? ***(Read and mark each one yes or no)***	Martha/Cliff at training **SPTrn**…… 0 / 1 NICHE enumerators **SPEnum** ……..0 / 1 My child from school **(Nyathina mani e skul)**…….0 / 1 Community Health Worker (**Jopuonj mag gweng')** ...0 / 1 Chiefs baraza (**Barasa mar gweng')**……..…0 / 1 Church Leaders/at Church **(Jopuonj mar Kanisa/ e Kanisa)** ……**SpChurch**……..0 / 1 Health facility **(Kar thieth)** **SPFacil**..……..0 / 1 Neighbor / family / friends (**Jirani/watni/osiepeni)**.. 0 / 1 Health Officer/Nurse **(Ja helth/sista/jothieth mantiere e gweng')** …**SPHO**…….…….0 / 1 Vendors **(Jous gige SWAP/NICHE)** **SPSwap**….. 0 / 1 Other **(Mamoko)** …**SPOth**……0 / 1 Don't know (**Akia)** …**SPDK**…….0 / 1
M7. **ANG'O MABIRO E PACHI MOKUONGO KALUWORE GI SPRINKLES?** WHAT IS YOUR IMMEDIATE FIRST REACTION TO SPRINKLES? **SPRxn** *(Don't read. Mark only one)*	It's a good idea (**en paro maber)** ….. ……..1 It's a bad idea (**ok en paro maber)** …….. .....2 I am not sure **(ok an ga diera)** .....3 Don't know (**Akia)** ..... ……..99
M8. **IPARO NI 'SPRINKLES' NI ITIYO GODO E YORE MAGE?** WHAT DO YOU THINK SPRINKLES IS USED FOR? *(Don't read. Mark all that apply)*	Appetizer (**Ndhandhu /keto dhok mamit)RxnApp**….1 Give energy, make active **(Medo teko) RxnEnergy** ..……1 Make child, family happy (**Keto nyathi, joot bedo gi mor)**

	…**RxnHappy**…….. .....1 Make child playful (**Keto nyathi hero tugo/ njejore)** …… RxnPlay…….....1 Grow healthy, make child healthy (**Miyo nyathi dongo kendo bedo kod ngima)** …**RxnHealth**……..1 Improved immunity (**Geng'o/kedo gi tuoche) RxnImmun…….....**.....1 Prevent low blood, adds blood (**Medo remo)** .,,,,,,,,,,,,.., 1 Make child stronger (**Keto nyathi bedo ma ratego**) … 1 Child smarter, build brain (**Nyathi bedo gi obuongo ma otegno / riek)** ……**RxnSmart**……..……..……1 Increase vitamin/minerals in body (**Medo chumbe mag del)** ……**RxnVit**……..…….…… …1 Sleep well/peacefully (**Nindo mayom/maber) ……..**1 Smooth healthy skin, prevent rashes (**Pien del bedo mayom, ma onge guonyo guonyo)** ….**RxnSkin**…….1 Hair strong, healthy, black (**Yier wich man gi ngima, ma otegno)**……**RxnHair**…… ……1 Prevent diarrhea (**Geng'o diep)** …**RxnDiarr**……..…1 Prevent malaria (**Geng'o malaria/midusi) RxnMal**……1 Improve body development (**Keto del dongo maber) RxnDevel**……..…….. .....…1 Other (**Mamoko**) **SpUseOth**…… ……...1 Don't know (**Akia) SpUseDK**…… ……..……1
M9. **'SPRINKLES' EN ANG'O?** WHAT ARE SPRINKLES? **SPWhat** *(Don't read. Mark only one)*	Powder with vitamins & minerals (or no mention of content) **(Poda man gi ndhandhu/chumbe mag del)** ……..…… …...…1

	Drug (medicine, drug in powder form) (**Yath/Yien**)……..2 Food (e.g., fruits) (**Chiemo**) ……..….3 Food supplement (might mention nutrients, food groups, v&m) **(Gik ma miyo chiemo teko mamoko)** ……4 Other **(Mamoko)**…….88 Don't know **(Akia)**……..99
M10. **SPRINKLES IMIYO JOK MA HIKGI ADI?** WHAT AGE GROUPS ARE SPRINKLES MEANT FOR? **SPAge** *(Don't read. Mark only one)*	6 months to 5 years **(Dweche 6 nyaka higni 5)**….. .. .1 Under 5 years (Explicitly includes those less than 6 months)**(Ma hikgi tin ne 5)** ..…. ……2 Young children (no age group mentioned) **(Nyithindo matindo)** …….... …. ……...3 Everybody **(Ng'ato ang'ata)** …… ……..4 Other **(Mamoko)**……..88 Don't know **(Akia)**……99
M11. **SPRINKLES ONEGO TIGO DIDI, TO MAROMO NADI?** **SPFreq** HOW OFTEN SHOULD SPRINKLES BE USED? *(Don't read. Mark only one)*	1 sachet per day per child……..…1 2 sachet per week ……...…2 1 sachet at every meal, every day ……..……...3 Episodic ……..…….. ..……..4 1 sachet a week ……..……..5 Other **(Mamoko)**…….……..….88 Don't know **(Akia)**……..…99
M12. **CHIEMO MAROMO NADI MONEGO MEDIE SPRINKLES?** TO WHAT SIZE PORTION OF FOOD SHOULD YOU ADD SPRINKLES? **SPPortion**	Small portion a child can consume ……..……..…1 Other **(Mamoko)**……..88 Don't know **(Akia)**…….……99

(Don't read. Mark only one)	
M13. **OWINJORE IMI CHIEMO MOKETIE SPRINKLES THUOLO MAROMO NADI ?** HOW SOON AFTER ADDING SPRINKLES TO FOOD SHOULD YOU WAIT TO SERVE IT TO THE CHILD? **SPSoon** *(Don't read. Mark only one)*	Immediately serve to child **(sano sano)** …… ....1 Other **(Mamoko)**……..88 Don't know **(Akia)**……99
M14. **BENDE OWINJORE IKET SPRINKLES EI CHIEMO KAPOD CHIEK?** IS IT RECOMMENDED TO POUR IN THE SPRINKLES SACHET WHILE THE FOOD IS COOKING ON THE FIRE? **SPFire** *(Don't read. Mark only one)*	No **(Ooyo)** ……..0 Yes **(Eee)** …… ……..……1 Don't know **(Akia)**……99
M15. **BENDE OWINJORE IMED SPRINKLES EI CHIEMO MALIW, KAKA PII, CHAK KATA CHAE?** IS IT RECOMMENDED TO ADD SPRINKLES TO LIQUIDS? **SPLiq** *(Don't read. Mark only one)*	No **(Ooyo)** ……..0 Yes **(Eee)** …… ……..……1 Don't know **(Akia)**……99
M16. **GIN RANYISI MAGE MANYISO NI SPRINKLES TIYO?** WHAT ARE SIGNS THAT SPRINKLES IS WORKING? *(Don't read, mark all that apply)*	Increased appetite **(Medo dhok mamit)**.**AppSP**…..…1 Increased energy **(Medo teko)** …**EnergSP**……1 Dark stool or change in color **(Losruok marateng')….**1 Loose stool, diarrhea **(Losruok marep rep, diep)**……1 Child happy **(nyathi mamor)**……**HappySP**……1 Child playful **(Nyathi mohero tugo/ma njejre)**…… 1 Child stronger **(Nyathi motegno)**….**StrongSP**…….1 Child healthy **(Nyathi mangima ne ber)..HealthSP**….1 Smooth skin, no rashes **(Nyathi ma dende yom, onge gwonyo gwonyo)**…**SkinSP**…… ……1 Improve immunity, prevent illness **(Geng'o/kedo gi tuoche)**……**ImmunSP**……

	…….1 Other (**Mamoko**)…**OtherSP**……..1 Don't know **(Akia)**…**DKSP**……1
M17. **OFUKU ACHIEL MAR SPRINKLES EN PESA ADI E GWENG'U KA?** HOW MUCH DOES A SACHET OF SPRINKLES COST IN YOUR COMMUNITY? **SPCost** *(Don't read. Mark only one)*	2 ksh per sachet……..1 5 ksh per sachet……..…2 1.5 ksh per sachet…….....3 1 ksh per sachet……..…..4 Other **(Mamoko)**……..…..88 Don't know **(Akia)**……99
M18. **BENDE IPARO NI NG'ENY JI NIGI NYALO MAR NG'IEW SPRINKLES E GWENG'U KA?** DO YOU THINK MOST PEOPLE CAN AFFORD TO BUY SPRINKLES IN YOUR COMMUNITY? **AffordSP** *(Don't read. Mark only one)*	Yes, it's affordable …… ……..…1 No, not affordable to all …… ….2 It should be free …….. …… ……..3 Other **(Mamoko)**…….88 Don't know **(Akia)**……99
M19. **PAKET ACHIEL MAR 'SPRINKLES' IPARO NI ONEGO OBED PESA ADI?** How much do you think one packet of Sprinkles should cost? **ThinkSpCost**	_____ **KSh**
M20. **KAPO NI PAKET ACHIEL MAR 'SPRINKLES' EN SILING' 5 INYALO THORO NG'IEWE BANG' NDALO ADI?** IF THE PRICE OF SPRINKLES IS 5 KSH PER SACHET, HOW OFTEN WOULD YOU BUY THEM? **FreqBuySP** *(Don't read. Mark only one)*	One a day…….1 Several times a week……..2 One a week .....3 Twice a month .....4 One a month.....5

	A few times a year .....6 Never.....7 Other……..…… ….88 Don't know **(Akia)**……99
M21. **IPARO NADE KA PAKET ACHIEL EN SILIN'G ABICH TO IDWARO MIYO NYATHINI DICHIEL KATA DIRIYO E JUMA?** WHAT DO YOU THINK ABOUT THE PRICE OF 1 SACHET FOR 5 KSH IF YOU ONLY NEED TO GIVE IT TO YOUR CHILD **ONCE OR TWICE** A WEEK? **SPOneTwo** *(Don't read. Mark only one)*	Price is OK……..……0 Price is too high……..……..…1 Price is too low…….2 Other **(Mamoko)**…….88 Don't know **(Akia)**……99
M22. **BENDE SPRINKLES NWANG'ORE MAYOT E GWENG' KA?** DO YOU THINK SPRINKLES ARE EASILY ACCESSIBLE FOR SALE IN YOUR COMMUNITY? **AccessSP** *(Don't read. Mark only one)*	No **(Ooyo)** …….....0 Yes **(Eee)** …… ……. ……..……..…1 Other **(Mamoko)**……..88 Don't know **(Akia)**……99
M23. **DIHER NG'IEWO 'SPRINKLES KA NYE?** Where would you like to buy sprinkles? *(Don't read. Mark only one)*	SWAP Vendor ……..……1 Community health worker/promoter…….……..2 **Jaus gige SWAP/Nyamrerwa** Pharmacist / chemist **Jaus yedhe/ od yath**……3 Health Facility **Kar thieth**……..4 Retail shops **Dukni**

	……...5 Chief's baraza **E barasa** ……...6 SWAP shop **Duka ming'iewe gige SWAP**……...7 Kiosk **(Kiosko)** ……8 Other…… …..88
M24. **BENDE ISEGA USO SPRINKLES?** HAVE YOU EVER SOLD SPRINKLES? **SoldSP** *(Don't read. Mark only one)*	No **(Ooyo)** ……0 Yes **(Eee)** …… …… ……..1
M25. **ANGO' MA MONO, KATA MOSE MONO JOMOKO MIYO NYITHINDO SPRINKLES E'GWE U KA?** WHAT ARE THE BARRIERS TO GIVING SPRINKLES TO CHILDREN IN THIS COMMUNITY? *(Don't read, mark all that apply)*	None **(Onge)**…**BarNone**…… 1 Cost - including lack of credit **(Nengo ne, onge mar hola)**……**BarCost**…….. … ……..1 Causes loose stool, diarrhea **(Losruok marep kata diep)** **BarDiarr**…… 1 Causes increased appetite **(Dhok mamit)**…**BarApp**….1 Parents are lazy, forgetful **(Samuoyo kata wichwil mar jonyuol)** **BarForget**……1 Child not sick and don't need **(Nyathi ok tuo)**……...1 Meant for children with HIV/AIDs **(Mar nyithindo man gi ayaki)**…**BarHIV**…… ……1 Don't know where to buy **(Akia kama anyalo ngiewe).** 1 Other **(Mamoko)**…**BarOther**…….. 1 Don't know **(Akia)** **BarDK**……1
M26. **BER KATA RACH MANE MA ISENENO E NYATHINI (NYITHINDI) BANG' TIYO KOD SPRINKLES?**	None **(Onge)** ……**EffNone**……..1

WHAT POSITIVE OR NEGATIVE EFFECTS DID YOU SEE IN YOUR CHILD(REN) AFTER USING SPRINKLES? *(Don't read, mark all that apply)*	Appetizer **(Keto dhok mamit)** …**EffApp**……..1 Give energy, make active **(Medo teko)** **EffEnergy**…..1 Make child, family happy **(Keto nyathi kod jo ot mamor) EffHappy** …… ……. … . ……1 Make child playful **(Keto nyathi matugo maber/ma njejre)**…**EffPlay**…….. ……1 Grow healthy, make child healthy **(Nyathi man kod ngima maber)** ..**EffHealth** …… ……1 Improved immunity **(Konyo e geng'o/kedo kod tuoche)**…**EffImmun**…….. …. ……..1 Prevent low blood, adds blood **(Medo remo teko)**…… 1 Make child stronger **(Keto nyathi tegno maber)**……1 Causes diarrhea **(Miyo nyathi diep)** …**EffDiarr**…….....1 Causes dark stool **(Keto losruok ma rateng'.....**1 Causes vomiting **(Kelo ng'ok) .EffVomit……1** Prevent diarrhea **(Geng'o diep)**…**EffNoDiarr**……1 Prevent malaria **(Geng'o malaria/midusi).EffNoMal…**1 Other **(Mamoko)**……**EffOther**……...1 Don't know **(Akia)**……**EffDK**……..1
M27. BENDE NE IMIYO NYATHINI SPRINKLES MONDO OTHIEDH NE TUO MORO KANE OTUO? DID YOU EVER GIVE YOUR CHILD SPRINKLES TO <u>TREAT</u> AN ILLNESS WHEN S/HE WAS SICK? **SPRTRTSICK**	No (Ooyo) ……..….....0 Yes (Eee) …… …… ……..……1 Don't know (Akia)……..…99
M28. **BENDE ISEYUDO ACHIEL KUOM MAGI?** HAVE YOU EVER RECEIVED ANY OF THE FOLLOWING?	Sprinkles calendar **(Kalenda mar sprinkles)**…..…0 / 1 Sprinkles leaflet/brochure **(Otase mag lando sprinkles)**… ……..... 0 / 1 Sprinkles cup **(Okombe mag lando sprinkles)**

(Read and mark each one yes or no)	……0 / 1 Sprinkles sticker**(Otas mibawo ma lando sprinkles)** 0/1 Sprinkles T-shirts **(sprinkles t-shirts)**.....0 /1
M29. **BENDE ISEYUDO SPRINKLES MA OCHIW NONO?** HAVE YOU EVER RECEIVED ANY FREE SPRINKLES FROM: *(Read and mark each one yes or no)*	Launch **(Romo makende mane e lande sprinkles)**..0/ 1 Training **(Tiegruok)**……..**FreeTrn**……0 / 1 Vendor **(Jauso)**……**FreeVen**……..……0 / 1 Neighbor/Friend/Relative **(Jirani/osiepni/watni)**…. 0 / 1 NGO, international agency (e.g., UNICEF)…. 0 / 1
M30. **BENDE NE IDHIYE TIEGRUOK KATA ROMO MAKENDE MI LANDE WECHE MAG SPRINKLES?** DID YOU EVER ATTEND ANY SPRINKLES TRAININGS OR LAUNCHES? **AttendSpr** *(Don't read. Mark only one)*	No **(Ooyo)** …….....0 Yes **(Eee)** …… ……. ……1 Other **(Mamoko)**……..88 Don't know **(Akia)**……99
M31. **Ere yo maber ma inyalo puonj godo mine wach mar sprinkles?** What are the best ways to pass on information about Sprinkles to mothers? *(Don't read. Mark all that apply)*	Radio, T.V. (**Nyakalondo, telebisen)**…….…… 1 Newspaper ……2 My child in school (**Nyathina mani e skul)**……..3 Brochure / Poster (**Jopuonj mag gweng**)……...4 Promotion show **Lendo mag bath ndara**…… 5 Community meetings/chiefs baraza **Barasa mar gweng'** …….....6

	Truck/loudspeaker **Mtoka man gi aujo** ……..7 Wall painting **Goro mar kor ot**…….……..…....8 Health facility **Kar thieth** ……..…….. 9 Neighbor / family / friends **Jirani/watni/osiepeni** ….. 10 Health Officer/Nurse/CHW **Jaelth/sista/jothieth mantiere e gweng' …..**……..……..…… 11 SWAP vendors **Jous gige SWAP**…….……..12 Other **Mamoko** ……..……..88 Don't know (**Akia)** ..... ……..……99

SPRINKLE USE

M32. KUOM JUMBE ARIYO MOSEKALO, OFUKU ADI MAG SPRINKLES MA IN KATA ACHIEL KUOM JOODI OSENG'IEWO KATA OSEYUDO NONO? OVER THE LAST 2 WEEKS, HOW MANY SPRINKLES SACHETS HAVE YOU OR ANYONE IN YOUR HOUSEHOLD PURCHASED OR RECEIVED FOR FREE? **NumSachet**	**_____ sachets**
M33. **BENDE JAODNI MORO AMORA OSETIYO GI SPRINKLES?** HAVE ANY HOUSEHOLD MEMBERS EVER USED SPRINKLES? **SPRINKLE** (DON'T READ. MARK ONLY ONE)	No **(Ooyo)** …….…….....0 Yes **(Eee)** …… ……..…… ……..……1 Don't know **(Akia)**……99
M34. **NYISA JOODNI MA JO SWECHE 6-59 MOSETIYO GI SPRINKLES?** PLEASE LIST ANY HOUSEHOLD MEMBERS **6-59 MONTHS OF AGE** WHO HAVE EVER USED SPRINKLES	1. _____

	2. _____ 3. _____ 4. _____ 5. _____
M35. **BENDE DANG' ANEE OFUKE MAG SPRINKLES MA IN GODO MA IBIRO TIYO GODO E ODI, KA IN JA USO KIK IKWAN MA IPARO NI IBIRO USO?** Can I see any sprinkles sachets you have available for your household use, do not include any sprinkles you intend to sell if you are a vendor. **SPObs**	Unopened Sprinkles Sachets available……. 1 Unopened Sprinkles Sachets not available…… 2 Opened Sprinkles Sachets available…….. 3 Refused …….. 99

HHID

Child Number

CHILD QUESTIONNAIRE (6 MONTHS TO 3 YEARS)

CHILD DEMOGRAPHICS

If the eligible primary caretaker is not present, schedule another visit to the household

C1. NYING NYATHI WHAT IS THE NAME OF THE CHILD?	----------
C2. NYATHINI ONYUOL KARANG'O? WHAT IS THE CHILD'S DATE OF BIRTH? **CDOB** ***IF DON'T KNOW THE DAY OR MONTH, ENTER 01,01***	**Day** **Month** **Year**
C3. WRITE THE SOURCE OF BIRTH DATE SOURCEDOB	Clinic book (Kad mar klinik) ..... 0 Baptismal card (Kad mar batiso) ..... 1 Birth certificate (Barup nyuol) ..... 2 Recall (Paro gi wich) ..... 3 Other (Mamok) 88

C4. EN WUOYI KOSO NYAKO SEX OF THE CHILD CSEX	Boy (Wuoyi) ..... 1 Girl (Nyako) 2	
C5. NYATHINI EN ANG'ONI? WHAT IS YOUR RELATIONSHIP TO THE CHILD? CHILDRELN	Biological Mother **Mingi monyuole** ……1 Female caretaker **Mama marite** ..... 2 Adoptive mother **Mama mokawe** ..... 3 Father **Babagi** ..... 4 Other……..... 88 Don't know 99	
CHILD – Micronutrient Module		
C6. BENDE NYATHINI OSEYUDI GI NOK MAR REMO EDENDE? HAS YOUR CHILD EVER BEEN DIAGNOSED WITH ANAEMIA? ANEMIA	No (Ooyo)……0 Yes (Eee)……1 Don't know (Akia)..... 99	
C7. BENDE SANI OMUONYO/OMADHO YIEN MAG NOK MAR REMO E DE? IS THE CHILD CURRENTLY TAKING IRON SUPPLEMENTS (E.G., RB TONE, NOT SPRINKLES)? CHILDIRON	No (Ooyo) ……0 Yes (E ee) ……1 Don't know (Akia) .....……99	**IF NO, GO TO C9**
C8. NOTIYO GI YIEND MEDO REMO DIDI E JUMA MOKALO? HOW MANY TIMES DID YOUR CHILD TAKE IRON SUPPLEMENTS (E.G., RB TONE, NOT SPRINKLES) IN THE LAST WEEK? TimesIron	☐☐ Number of times *(IF 'DON'T KNOW', ENTER 99)*	

C9. ANG'O MOMIYO NYATHINI OK TI GI YIEN MAMEDO REMO SANI? WHY IS YOUR CHILD NOT TAKING IRON SUPPLEMENTS (E.G., RB TONE, NOT SPRINKLES) CURRENTLY? NOIRON *(DON'T READ. MARK ONLY ONE)*	Child does not need it; he is healthy **(Onge tiende, nyathi ngimane ber**) ..... ……..……1 Terminated treatment **(Osetieko thieth)** ..... ….…..2 Do not have money to buy iron **(Aonge pesa mar ng'iewo)** ... …….3 Child had an adverse reaction to iron (**Okelo tabu e dend nyathi)** ..... …….4 Child has not been able to see medical provider **(Nyathi pok oneno laktar**) .....5 Do not have access to iron (**Onge kama iyudo e yedhe go)** ..... ……..…6 Other, specify (**Mamoko)** .....……..88 Don't know (**Akia**) ……...99

CHILD – Breastfeeding Module		
C10. **BENDE (NYING) OSEGA DHOTH?** HAS THE CHILD EVER BEEN BREASTFED OR BEEN FED BREAST MILK? **EVERBREAST**	No **(Ooyo)** ……..……0 Yes **(Eee)** ……..……1 Refused (**Notamore)** ..... 77 Don't know **(Akia)** 99	**IF NO OR DK, GO TO C13**
C11. **KACHAKRE NYORO SECHE MACHALO GI MAGI BENDE (NYING) OSEDHOTH?** SINCE YESTERDAY, A TIME LIKE THIS, HAS THE CHILD BREASTFED? **BREASTYEST**	No (**Ooyo)** ..... 0 Yes (**Eee)** 1	
C12. **NYATHINI NOWEYO DHOTH KAJA HIGNI ADI?** AT WHAT AGE DID YOU STOP BREASTFEEDING THE CHILD? **StopBrMon**	☐☐ Months *If don't know then '99'* *If still breastfeeding then '66'*	
C13. **CHAKRE NYORO SAA MACHALO KAMA, BENDE NYATHINI NOSE MADHO CHAE?** SINCE YESTERDAY, AT A TIME LIKE THIS, DID THE CHILD DRINK ANY TEA? **TEAYEST**	No **(Ooyo)**……0 Yes (**Eee**)……1 Don't know **(Akia)**……	

C14. **CHAKRE NYORO SAA MACHALO KAMA, BENDE NYATHINI OSECHAMO CHILO, BURU, LOWO KATA ODOA?** SINCE YESTERDAY, AT A TIME LIKE THIS, HAS THE CHILD EATEN DIRT, EARTH, OR ODOA? **EATEARTH**	No **(Ooyo)**.....0 Yes (**Eee**)..... 1 Don't know **(Akia)**..... 99	**IF NO OR DK, GO TO C16**
C15. **KUOM NDALO ABIRIO MOKALO GIN NDALO ADI____ MANE NYATHINI CHAMO CHILO,BURU,LOWO KATA ODOA?** OVER THE LAST WEEK (7 DAYS), ON HOW MANY DAYS DID THE CHILD EAT DIRT, EARTH, OR ODOA? **DAYSEARTH**	☐☐ days (*If don't know then '99'*)	

CHILD – Malaria & general health Read: "Koro adwaro penji weche kaluwore gi ngima mar nyathini" **Now I'm going to ask you a few questions about the health of your child"**		
C16. **BENDE NYATHINI OSEBEDO KA DIEWO KUOM NDALO ACHIEL MOKALO?** HAS THIS CHILD HAD DIARRHEA IN THE LAST 24 HOURS? **(≥3 LOOSE OR WATERY STOOLS IN A 24 HOUR PERIOD)**	No **(Ooyo)**.....0 Yes (**Eee**).....1 Don't know **(Akia)**..... 99	
C17. **BENDE OSEBEDO GI TUO MAR KOR MATHUNG' KATA AHONDA KUOM NDALO ACHIEL MOKADHO? RESP24H** HAS THIS CHILD **HAD** RESPIRATORY ILLNESS IN THE LAST 24 HOURS? **(COUGH OR BREATHING PROBLEMS)**	No **(Ooyo)**.....0 Yes (**Eee**).....1 Don't know **(Akia)**..... 99	
C18. **BENDE OSEBEDO GI DEL MAORE KUOM NDALO ACHIEL MOKADHO?** HAS THIS CHILD HAD A FEVER IN THE LAST 24 HOURS? **FEVER24H**	No **(Ooyo)**.....0 Yes (**Eee**).....1 Don't know **(Akia)..**..... 99	
C19. **BENDE OSEBEDO GI MALARIA EJUMBE ARIYO MOKALO? MAL2WKS** HAS THIS CHILD HAD MALARIA DURING THE LAST 2 WEEKS?	No **(Ooyo)**.....0 Yes (**Eee**).....1 Don't know **(Akia)**..... 99	
C20. **BENDE NYATHINI OSENINDO E HOSPITAL KUOM JUMBE ARIYO MOKADHO? HOSP2WKS** HAS THIS CHILD BEEN HOSPITALIZED IN THE LAST 2 WEEKS (14 DAYS)?	No (**Ooyo**).....0 Yes **Eee)**.....1 Don't know **(Akia)**..... 99	**IF NO OR DK, GO TO C22**
C21**. NE EN GI CHANDRUOK MANE?** WHAT WAS THE HEALTH PROBLEM? **HOSPHPROB**	Diarrhea (**Diep**) ..... 1 Respiratory infection (**Kor mathung'**) ..... 2 Malaria **(Mhidusi)** ..... 3 Other **(Mamoko)** 88	

	Don't know **(Akia)..** 99
C22. **BENDE NYATHINI NONINDO E BUO NET NYORO GOTIENO?** DID (NAME) SLEEP UNDER A MOSQUITO NET LAST NIGHT? **CHLDSLPITN**	No (**Ooyo)**……0 Yes **Eee)**……1 Don't know **(Akia)** 99
SPRINKLES USE MODULE	
C23. **BENDE NGANI OSETIYO GA GI SPRINKLES?** HAS (NAME) EVER USED SPRINKLES? **SPRKUSEEVER**	No (**ooyo**)……0 Yes (**Eee**)……1 Don't know (**Akia**)……..99
C24. **CHAKRE ODIECHIENG' MANYORO NYAKA SANI (KAWUONO) BENDE ____ OSETIYO GI SPRINKLES?** SINCE YESTERDAY UNTIL NOW—TODAY, HAS THIS MEMBER USED SPRINKLES? SprkUseYest	No **(Ooyo)** ……..…….....0 Yes **(Eee)** …… ……..…… ……..……1 Don't know **(Akia)**……..……..…99
C25. **KUOM NDALO ABIRIYO MOSEKALO KOCHAKORE KAWUONO, NG'ANI OSETIYO GI SPRINKLES ADI?** STARTING WITH TODAY, OVER THE LAST 7 DAYS HOW MANY SPRINKLES SACHETS DID <CHILD'S NAME> CONSUME? **SPRKUSE7DAYS**	☐☐ sachets
C26. CHAKRE KAWUONO, KIDOK CHIEN NDALO ABIRIYO MOSEKALO, NDALO ADI MA (NG'ANI) OSETIYO GI SPRINKLES? Starting with today, over the last 7 days on how many days has <child's name> used Sprinkles? SprkDays7Days	☐☐ Days

*Enumerator: Is there another **SELECTED** child 6-35 months that lives in this household?*

*If **Yes,** Fill out another CHILD Questionnaire If **No**, end of survey*

---------- That is the last question. Thank you for answering our questions. ----------
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