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*Research Article*

# Effects of Occupational Exposure to VAT Dye on Fertility and Pregnancy Outcome of Women Dye Users

***Soyinka O.O.[a], Oritogun K.S. [b], Amballi A.A.[c], Olorundami B.O.[d] and Ogundahunsi, O.A.[e]**

*[a]Department of Chemical Pathology and Immunology, Olabisi Onabanjo University, Sagamu Campus;*
*[b]Department of Community Medicine, Olabisi Onabanjo University, Sagamu Campus;*
*[c]Department of Chemical Pathology and Immunology, Olabisi Onabanjo University, Sagamu;*
*[d]General Hospital, Iperu, Ogun State;*
*[e]Department of Chemical Pathology and Immunology, Olabisi Onabanjo University, Sagamu Campus;*

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**Abstract**
Textile dye exposure has been associated with diverse health disorders among which are infertility and adverse pregnancy outcome. Several such dyes exist in commerce; an example of which is vat dye. It is not known if occupational exposure to vat dyes as used by textile dyers in Abeokuta is associated with adverse reproductive outcomes. The present study was therefore conducted to investigate the influence of occupational vat dye exposure on fertility and adverse pregnancy outcome of dye users, by comparison with individuals not occupationally exposed. Biodata, occupational, reproductive and lifestyle characteristics were collected through interviewer administered questionnaire. The minimum duration of exposure was two years, mean age of the exposed participants was 32.5±8.1 years, and that of the unexposed was observed to be 37.7±5.9 years. Prevalence of Infertility, Miscarriage, and Low Birth Weight among the exposed versus the unexposed were 40.5%, 27% and 9.1% versus 35.5%, 22.6% and 0.0% respectively. These Percentages were higher in the exposed but no significant association was observed between Infertility, miscarriage, low birth weight and occupational exposure to vat dyes in the context of this study. Occupational exposure to vat dyes used by textile dyers in Abeokuta is not associated with significant adverse reproductive outcomes. This study, being retrospective type, could have been limited by recall bias. It is therefore recommended that a Prospective Study of this population be conducted and on a larger scale which may involve multiple study centers

**Key Words:** *Infertility, Low birth weight, miscarriage, vat dye, dye users, occupational exposure*

## INTRODUCTION

A number of occupations are being reported to be associated with reproductive dysfunctions in males and in females (Kumar 2004; Burdorf e*t al.,* 2006). Such occupations include manufacture or application of some degradable chemicals as well as bio-accumulative chemicals; occupations involving intensive exposure to heat and radiations, those involving the use of toxic solvents and fumes Kumar 2004). The presence of these hazardous conditions in work-places has raised concerns about their potential effects on fertility, pregnancy outcomes such as spontaneous abortion, stillbirth, pre-term birth, small-for-gestational age and birth weight as well as birth defects in offspring from interaction with foetal developments (Lawson *et al.,* 2003; Burdorf *et al.,* 2006). Much more, apart from direct effects on exposed male reproductive system, exposure in male may contribute to negative pregnancy outcomes and birth defects in females (Kumar 2004; Burdorf *et al.,* 2006)

Textile dyeing is an age-old process aimed at producing better quality and more fascinating textile products (Klemola, 2008). It forms an integral part of textile industries (Singhi *et al.,* 2005) where a wide range of chemicals are used for dyeing operation (Liaqat, 2009). These include dyes such as vat dyes, azo dyes, sulphur dyes, disperse dyes and allied chemicals. During dyeing, dye molecules are deposited from solution unto materials in such a way that they cannot be removed by the original solvent. Fibre reactive dyes form a covalent bond with the fibre while other dyes require prior application of a mordant, an inorganic material that causes the dye to precipitate as an insoluble salt.

Some textile dyes have been shown to be harmful on female reproductive health, pregnancy outcome and developmental outcome in animal model (Gray and Ostby 1993; Tanaka, 1997; Fernandes *et al.,* 2015). In human, female exposure to textile dyes has been associated with infertility similar to several other chemicals (Rachootin and Olsen 1983; Fernandes *et al.,* 2015). Furthermore, some components of textile dye (heavy metals and solvents) have been associated with reproductive dysfunction (Donald *et al.,* 1991; Rybicki *et al.,* 2004; Tuzen *et al.,* 2008; Soaga and Opeolu 2009). A Study on untreated and treated textile dye wastewater showed toxicity to reproductive biology of male Albino mice and rats

**Author for Correspondence:* Tel: +234 803 712 3058 E-mail: *Soyinka.oluwatosin@oouagoiwoye.edu.ng*

(Suryavathi *et al*., 2005). Women who used hair dye pre-pregnancy had significantly high risk of low birth weight infants (Jiang *et al.*, 2018)

Above all, earlier studies performed on this population of dye workers in Abeokuta showed that the textile dye effluent contains substances toxic to animal physiology with potential to cause severe health malaise in the habitants of the community (Akinleye *et al.*, 2008; Oloyede *et al.*, 2014; Soaga and Opeolu, 2009; Oguntade *et al.*, 2015).

To study the effects of Workers' exposure to vat textile dyes on reproduction, we focused on the Dyers, who seem to have high quantum of exposure from work and because it has been reported that effects of exposures such as these, are better studied using occupational exposure than environmental exposure. Such results can then be extrapolated to the general public (Gardiner *et al.,* 1982). Therefore, this study aimed at evaluating possible reproductive health effects of vat dyes among occupationally exposed individuals and wives of exposed male subjects. In this Paper, we investigated reproductive areas such as infertility and adverse reproductive outcomes (miscarriage, still birth, low Birth weight and Birth defects).

## MATERIALS AND METHODS

This cross-sectional retrospective study was conducted among a cohort of 37 textile dyers at "Itoku", "Abeokuta", South Western Nigeria by Purposive Sampling Technique. Inclusion Criteria are minimum of two-year duration of exposure to vat dye and participants (male and female) who either have being married or cohabiting within reproductive age. Ethical clearance and approval were obtained from the Scientific and Ethical Review Committee of Olabisi Onabanjo University Teaching Hospital, "Sagamu", Ogun State. Consent Paper was signed by all the subjects that participated in the study. Thirty-one (31) unexposed participants from Abeokuta Environ were used as controls.

An interviewer-administered semi structured questionnaire written in English language was used to obtain information on socio-demographic, occupational and reproductive characteristics. The questionnaire was interpreted to the local language which was "Yoruba" and was so administered after training of three interviewers.

The socio-demographic aspect of the questionnaire included the age, sex, weight, height, marital status. The height and weight were measured as described by Sánchez-García *et al.,* 2007) with the participants wearing light clothes without shoes. The weight was measured in kilograms with a bathroom scale (Hanson, China), the height was measured in "cm" using a long calibrated meter rule, and this was converted to meter by dividing by 100. The major aspect of occupational history reported was duration of exposure (in years). With respect to reproductive history, a participant is reported to experience infertility if his or her response to the question "Is there any time that you and your spouse desired to be pregnant and the pregnancy was not achieved for up to a year?" was yes. Pregnancy outcome was expressed by answering "Yes" to the presence or "No" to the absence of any of such variables as miscarriage, still birth and ectopic pregnancy and the particular parameter was ticked appropriately.

Parameters of birth outcome reported were prematurity, low birth weight [LBW, defined as baby less than 2.5 Kg (Muchemi 2015)] and presence of multiple births. Birth defect was reported separately and is related to any physical abnormality for example in the head, mouth, hand and leg. Each experience or event captured was linked to the exposure time.

### Statistical Analysis:

The statistical analysis was carried out using Statistical Software Package for Social Sciences, SPSS version 20. Descriptive statistics such as frequencies and percentages were generated for categorical variables while means and standard deviations were for quantitative variables. Inferential statistics such chi-square test and T-test were employed to test for associations of categorical variables and differences in mean values respectively. The p-value less than 0.05 was considered to be significant.

## RESULTS

There were a total of 68 participants in this study. The exposed group comprised of 37 participants, made up of 6 males and 31 females while the unexposed were 31, comprising of 2 males and 29 females. No significant difference was observed between the proportion of males to females in the two groups ($p>0.05$). The mean body weight and height of the exposed were similar to those of the unexposed. ($p>0.05$). The mean duration of exposure to vat dye by the dye workers was observed to be over a decade (as seen in Table 1).

**Table 1:**
Demographic Characteristics of Vat Dye Workers and the unexposed participants

| Parameter | Exposed | Unexposed | t/$X_2$ | P-value |
|---|---|---|---|---|
| | **n (Mean ± SD)** | **n (Mean ± SD)** | T | |
| **Age** | 36(32.5 ±8.1) | 31(37.7 ±5.9) | 2.94 | 0.05 |
| **Weight** | 35(61.4 ± 12.1) | 30(65.0±11.8) | 1.22 | 0.23 |
| **Height** | 36(1.6 ±0.1) | 29(1.6 ±0.7) | 0.51 | 0.61 |
| **MDE per week(hours)** | 37(53.4±12.5) | NA | NA | NA |
| **MDE(years)** | 37(13.1±11.1) | NA | NA | NA |
| **Sex** | **37** | **31** | $X_2$ | |
| Male | 6 (16.2%) | 2 (6.5%) | 1.55 | 0.27 |
| Female | 31 (51.7%) | 29 (93.5%) | | |

MDE= Mean Duration of Exposure; t = t value; $X_2$ = **Chi-S**quare; P=Probability; n=no of subject that responded; NA= Not applicable.

**Table 2:**
Frequency of infertility and adverse Reproductive factors in the Vat Dye exposed and the unexposed Participants

| | Exposed | Unexposed | $X_2$ | P-value |
|---|---|---|---|---|
| **Infertility** | n= (37) | n=(31) | | |
| Yes | 15(40.5%) | 11(35.5%) | 0.18 | 0.80 |
| No | 22(59.5%) | 20(64.5%) | | |
| **Birth Defect** | **n=36** | **n=29** | | |
| Yes | 0(0.0%) | 3(10.3%) | 3.90 | 0.08 |
| No | 36(100.0%) | 26(89.7%) | | |
| **Delivery outcome** | **n=33** | **n=29** | | |
| Prematurity | 3(9.1%) | 1(3.4%) | | |
| LBW | 3(9.1%) | 0(0.0%) | 4.76 | 0.19 |
| Multiple birth | 0(0.0%) | 1(3.4%) | | |
| None | 27(81.8%) | 27(93.1%) | | |
| **Pregnancy Outcome** | **n=37** | **n=31** | | |
| Miscarriage | 10(27.0%) | 7(22.6%) | 0.18 | 0.78 |
| None | 27(73.0%) | 24(77.4%) | | |

P = Probability, n=no of subject that responded, %=percentage
$X_2$ =chi square, P > 0.05= not significant

As shown in Table 2, among the exposed, about forty percent of the participants had at one time or the other suffered from Infertility during their exposure period. This was not significantly different from the experience of the unexposed, among whom about thirty-five percent suffered such (p>0.05). None of the exposed participants reported any form of obvious birth defect, while about ten percent among the control subjects reported such. Low Birth Weight was observed among nine percent of the exposed subjects, while, none of such was reported among the exposed. The prevalence of prematurity among the exposed was about nine percent and about three percent among the unexposed. There was no significant difference between the proportion of participants with prematurity, low birth weight and multiple birth among the two groups (p>0.05). Twenty-seven percent of the exposed participants had miscarriage and similarly about 22 percent of the unexposed experienced such among the unexposed (p>0.05).

## DISCUSSION

Infertility, adverse pregnancy outcome (such as spontaneous abortion, prematurity, low birth weight) and birth defects including neural tube defects as well as cleft palate have been associated with certain occupational exposures (Grajewski and Schnorr.,1992; Burdorf *et al.*, 2006, Sakr *et al.*, 2010, Shah and Farrow, 2014). Such Occupations include works with chemical agents, examples of which are lead, organic solvents, mercury, anaesthetic gases, carbon disulfide and pesticides (Burdorf *et al.*, 2006). Studies associating reproductive disorders or dysfunctions with dyes exist among Hairdressers using hair dyes and solvents (Peters *et al.*, 2010, Jiang *et al.*, 2018). Other Studies on effects of Exposure to dyes on reproduction exist mainly in animal models and in males. There is paucity of data on effects of occupational exposure to dyes and reproductive dysfunctions particularly in Females. This Study was carried out in Abeokuta, the Capital of Ogun State of Nigeria. Abeokuta is synonymous to textile dyeing and very few studies have been carried out among the dye workers on how their Works relate to their Health. The dyes in use are mainly vat dyes. These are allowed to react with Sodium Hydrosulphite and Sodium Hydroxide in hot water during dyeing with the release of gaseous product which smells like rotten egg and which can be perceived by the workers and all around. In this way, the workers and nearby people are exposed via inhalation (Salmani, 2014). Exposure may also be through ingestion while working and at the same time eating snacks. The present study is a Reproductive Outcome Research. The aim was to investigate Reproductive toxicity among the dye workers. This refers to the continuum of adverse effects that may befall an exposed young worker, parent, or pregnant woman and her offspring exposed *in utero* (Lawson *et al.*, 2003). In this study, we investigated the effect of occupational exposure to vat textile dye on prevalence of infertility and adverse reproductive outcomes such as low birth weight, miscarriage, prematurity and birth defects as outcomes of reproductive performance (Lawson *et al*., 2003).

It was observed that vat dye exposure among dye workers at "Itoku", "Abeokuta" is not associated with infertility from the point of view of clinical Infertility, defined as the ability of a sexually active couple, not using any birth control, to get pregnant after one year of trying (Cedars and Jaffe, 2005). This is not consistent with the studies of Rachootin and Olsen (1983) that observed association of textile dye exposure with infertility by a case control study utilizing data collected from medical records. Both Studies were based on questionnaires. In this study, we considered only vat dye exposure, while Rachootin and Olsen (1983) focused on textile dyes generally. Different dyes have different functional groups and therefore react differently. Their reports of infertility could have been due to the contribution of another class of dye present among the general dyes considered. The prevalence of infertility reported among the textile dye workers (40.5%) seems to be a little bit high but was observed to be similar to that of the unexposed (35.5%) and was not so different from some prevalent studies of infertility in Nigeria among this age group. Olugbenga Bello *et al.*, (2014) reported a prevalence of 44% in a Hospital based Study, Sule *et al.*, (2008) reported 31.5% also in a Hospital based Study. On the other hand, no prevalence report was found for Ogun state, but Olatunji and Sule-Odu (2003) reported incidence of infertility at Ogun State Teaching Hospital as 14.8%, and Panti and Sununu (2014) as 15.7%. Fernandes *et al*., (2015) in their Study, reported decreased fertility in association with dye exposure. However, unlike in our study, they utilized azo dye in animal model and only in male. The decreased fertility that they observed was as

a result of testicular toxicity, and from an experimental study. Our result was based on interview using Interviewer administered questionnaire which could have been affected by "recall". Reduced fertility reported by Gray and his Team (1993) was as a result of developmental toxicity experienced by offspring of dams who had prenatal exposure to dye. This affects the gonads of both male and female offspring, but only the female offspring were reported to display reduced fertility. In this study our focus was not strictly on developmental toxicity but on a group of workers who have exposure to vat textile dye with a mean duration of 13.11 ±11.05 years.

There were no adverse reproductive outcomes such as (miscarriages, ectopic pregnancies or stillbirths, premature baby or Low birth weight baby among the study participants as reported in some other occupational and chemical exposures (Jiang *et al*., 2018, Peters *et al*., 2010). Also, no birth defects, such as limbs deformity, urogenital abnormality, orofacial cleft and congenital heart defect as reported by Peters (2010) were found as effects of occupational exposure to vat dyes. Our result on LBW was not consistent with that of Jiang *et al.*, (2018), who reported that women who used hair dye pre-pregnancy had significantly high risk of low birth weight infants.

In contrast to observations in this study involving occupational exposure to vat dyes, Xu *et al.*, (1998) reported a significant increased risk of spontaneous abortion for women working in production plants with frequent exposure to petrochemicals. Taskinen *et al.*, (1999) reported an association between exposure to formaldehyde and an increased risk of spontaneous abortion. Furthermore, Wennborg *et al.,* (2002) associated solvents exposure with an increased risk of preterm births.

In conclusion, occupational exposure to vat dye at "Itoku" "Abeokuta" with a mean duration of exposure of 37 (13.1 ±11.1) is not associated with significant adverse reproductive effects such as infertility, prematurity, low birth weight and obvious birth defects. However, prevalence of prematurity and low birth weight among the dye workers were each observed to be 9.1%. Limitation of this study include recall bias and small sample size. It is said that early fetal losses are often not seen by a Physician (Grajewski and Schnorr 1992), therefore, it is possible that some fetal losses were missed in this method of assessment. A prospective study on this subject matter may therefore provide more robust results. If possible, multi populations of dye workers could be studied to enable large sample size.

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